UNITED STATES DEPARTMENT OF AGRICULTURE

REPORT ON THE AGRICULTURAL EXPERIMENT STATIONS, 1933

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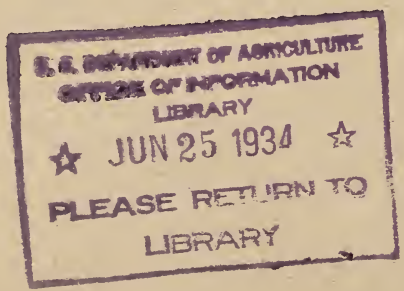

UNITED STATES DEPARTMENT OF AGRICULTURE
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Washington, D.C. June 1934

REPORT ON THE AGRICULTURAL EXPERIMENT STATIONS, 1933

By J. T. Jardine and W. H. Beal [1]

CONTENTS

INTRODUCTION

The purpose of this report is to show the use made of the Federal funds, amounting to $4,462,560, appropriated in the Hatch, Adams, Purnell, and supplementary and special acts for the support of State agricultural experimental stations and those under the supervision of the Department of Agriculture in Alaska, Hawaii, and Puerto Rico, as well as of $11,114,000 of State and other funds provided for the same purpose during the year ended June 30, 1933; to indicate the contributions of the stations to the solution of some of the major problems of rural life and well-being; and to review the progress made in coordinating the work of the stations with that of the Department and other agencies for more economical and efficient use of funds in agricultural research. The report also discusses briefly personnel, additions to permanent equipment, research programs and projects and their coordination and adjustment to meet more fully present conditions and needs, trends in station research, and various matters relating to organization, administration, and functioning of the stations as research and service agencies.

FINANCIAL SUPPORT

For the year ended June 30, 1933, the experiment stations reported a total financial support of $15,576,632.98, which, compared with $17,245,163.83 received the preceding year, represented a reduction of $1,668,530.85, or 9.6 percent. Of the total support, $4,359,000 was derived from appropriations under the Hatch, Adams, and Purnell Acts and $103,560 from appropriations to the Department of Agriculture for the maintenance of the experiment stations in Hawaii and Puerto Rico.

Table 1 shows the total income of the stations from all sources for the fiscal years 1932 and 1933.

[1] With the collaboration of other members of the Office staff.

41656—34——1

TABLE 1.—*Income of the experiment stations from all sources for the fiscal years 1932 and 1933*

Source of funds	1932	1933
Hatch Act	$750,000.00	$750,000.00
Adams Act	727,000.00	729,000.00
Purnell Act	2,880,000.00	2,880,000.00
Special Federal appropriations for stations in Alaska, Hawaii, Puerto Rico, Guam, and the Virgin Islands for 1932, and for stations in Hawaii and Puerto Rico for 1933	230,030.00	103,560.00
State appropriations and allotments	9,501,097.10	7,740,247.56
Fees	434,424.62	414,415.94
Sales receipts	1,311,711.64	1,151,251.92
Miscellaneous income	589,509.12	509,242.70
Balance from previous year	821,391.35	1,298,914.86
Total	17,245,163.83	15,576,632.98
Income 1932 over that of 1933	1,668,530.85	

The supplementary funds from other than Federal sources are given by States in table 2.

TABLE 2.—*Income of the experiment stations from other than Federal sources for the fiscal years 1932 and 1933*

Station	1932	1933	Station	1932	1933
Alabama	$200,256.89	$275,310.94	Nebraska	$214,075.26	$181,024.53
Alaska		1,167.70	Nevada	9,510.55	8,064.51
Arizona	113,894.76	94,530.68	New Hampshire	50,626.23	44,695.09
Arkansas	112,441.49	94,135.87	New Jersey	721,277.66	508,043.95
California	1,203,083.54	1,110,086.88	New Mexico	51,350.41	48,182.44
Colorado	163,712.14	130,884.60	New York (Cornell)	937,362.95	1,056,263.39
Connecticut (State)	265,641.19	277,315.94	New York (State)	485,345.66	439,281.96
Connecticut (Storrs)	55,431.66	52,048.11	North Carolina	141,605.86	103,861.96
Delaware	37,148.87	30,763.90	North Dakota	211,641.55	194,763.70
Florida	360,497.66	358,654.83	Ohio	1,162,788.18	651,631.41
Georgia	39,135.07	42,558.48	Oklahoma	204,140.36	174,802.10
Hawaii	30,148.69	29,071.92	Oregon	241,616.80	201,833.20
Idaho	52,021.58	35,664.88	Pennsylvania	166,779.82	134,384.31
Illinois	482,392.59	380,910.03	Rhode Island	6,209.52	7,602.64
Indiana	657,694.98	601,811.62	South Carolina	131,467.80	96,311.45
Iowa	301,695.80	294,419.06	South Dakota	48,823.25	45,065.78
Kansas	217,958.02	175,248.05	Tennessee	44,436.84	29,075.21
Kentucky	308,363.83	221,470.13	Texas	557,663.81	543,601.67
Louisiana	141,368.27	128,971.94	Utah	95,485.57	74,565.79
Maine	58,521.62	68,611.17	Vermont	24,011.87	22,619.13
Maryland	119,905.70	136,363.81	Virginia	129,685.99	86,665.93
Massachusetts	277,943.28	240,301.01	Washington	126,560.63	120,645.11
Michigan	350,694.93	297,163.15	West Virginia	107,929.29	86,980.70
Minnesota	399,311.37	387,322.99	Wisconsin	441,532.73	372,129.86
Mississippi	34,401.42	90,194.85	Wyoming	85,889.85	84,549.57
Missouri	143,624.22	116,159.72			
Montana	133,025.82	126,285.33	Total	12,658,133.83	11,114,072.98

The income of the experiment stations from other than Federal sources, $11,114,072.98, was 71.4 percent of the total. It was $1,544,060.85, or 12.2 percent less than for the preceding year, due mainly to a decrease in State appropriations and allotments from $9,501,097.10 to $7,740,247.56, or 18.5 percent. The income from fees was 4.6 percent, from sales 12.2 percent, and from miscellaneous sources 13.6 percent less than in the previous year. This was offset to some extent by an increase of over 50 percent in balances carried over from the preceding year.

The decline in State support from the all-time high of 1931, which began in 1932, was still further accentuated in 1933. Only eight stations, namely, Alabama, Connecticut (State), Georgia, Maine, Maryland, Mississippi, New York (Cornell), and Rhode Island, reported increases from State sources during the year. The other stations experienced reductions in income of from 1.5 to 43.9 percent. In the aggregate the Federal Government contributed about $1 to every $2.50 from other sources for the support of the stations during the year.

A detailed statement of station income and expenditures will be found on pages 66–78.

PERMANENT IMPROVEMENTS

Additions to permanent improvements such as land, buildings, and the like, used partly or wholly for station purposes, were, as would be expected, less extensive during the past year than in previous years. The amount expended for buildings and equipment during the year ended June 30, 1933, was $1,452,327 as compared with $1,885,003 the preceding fiscal year, showing a decline of more than 20 percent in such expenditures. Some important additions to buildings and other permanent improvements were, however, made during the year. Among these were the following:

A greenhouse completed at the Arkansas fruit and truck branch station at Hope, at a cost of about $1,000, provides increased facilities for plant-disease investigations carried on there.

An entomological building was completed at the Citrus Experiment Station at Riverside, Calif., at a cost of $150,000. This consists of a main part, 45 by 100 feet in size, with a wing 42 by 45 feet. The building is modern throughout in construction and equipment. It includes among other things a spray-application laboratory with necessary equipment, a vacuum fumigator installation and special apparatus for the study of fumigants, a series of cabinets with temperature and humidity control, and an attic greenhouse for the study of plant life in relation to insect attacks and control methods.

Three new brooder houses were added to the equipment of the poultry plant of the Delaware station to provide better facilities for poultry investigations, which are a leading feature of the work of the station.

Ten acres of additional land was acquired for the Citrus Experiment Station at Lake Alfred, Fla., at a cost of $600, and a citrus packing shed with necessary equipment was built at a cost of $800. These supply additional facilities which have been much needed for some time.

A tract of 3,646 acres of forest land on Moscow Mountain, about 20 miles from the University of Idaho, was donated to the university for the development of an experimental forest. This tract is to be known as the Moscow Mountain Experimental Forest. In addition to being used for educational purposes, it will serve as a field for study of methods of silvicultural management, especially natural regeneration.

A fireproof genetics-research laboratory with equipment, completed by the Iowa station at a cost of slightly more than $11,000, makes more adequate provision for office, laboratory, and other facilities needed for the development of work of the station in plant and animal genetics. The building is a story and a half in height. The ground floor, occupying a space of 32 by 65 feet, contains rooms for experiments with small animals, a root cellar, a room for the incubation of chicks, and a utility or workroom. The upper floor provides for seed storage, a laboratory for plant-genetics research, office rooms, and three laboratories for general biological work.

A new dairy barn and experimental laboratory, constructed of native limestone in conformity with other buildings on the college campus, was built at the Kansas station at a cost of $45,000. The structure provides additional facilities for feeding and digestion experiments and for handling the milk produced. A laboratory building for crop and soil investigations was completed at the Fort Hays substation at a cost of $10,500. This structure, 42 by 54 feet in size, with two stories and basement, contains a series of laboratory rooms and a large storage room for crop material.

Permanent improvements at the Maine station included a greenhouse at the central station at Orono, costing approximately $8,600; cold storage for apples at Highmoor Farm, Monmouth, at a cost of about $7,300; and a water system at the same place costing about $2,800. The cold-storage plant, constructed in the basement of the barn, is approximately 74 by 32 by 7.5 feet, and is properly insulated and provided with refrigeration. Both the greenhouse and the storage plant furnish much-needed facilities for station work.

The dairy building, erected by the Michigan College in 1910, was completely remodeled to provide among other facilities a nutrition-research laboratory, supplying improved means for investigations in that field.

A new agronomy field house for which the State legislature appropriated $30,000 was formally dedicated at the Minnesota station January 18, 1933. The new structure, 40 by 80 feet

in size, contains a large room for the storage of grains and grain samples before drying and threshing, a laboratory for corn-improvement studies, a series of drying ovens for determining moisture content of forage and crop samples, cleaning devices, weighing and threshing rooms, and other features which will greatly facilitate the extensive breeding work of the station with field crops.

A fireproof seed house and agronomy laboratory was built at the Nebraska station at an approximate cost of $30,000. This building, which is 40 by 90 feet in size and three stories high, provides a laboratory, several drying rooms, and a fumigating room in addition to storage facilities for certified grain and other seed.

A new building costing about $700 and improved laboratory facilities were provided for the study of poultry diseases at the New Hampshire station.

Important additions were made to barns and other equipment of the James Turner Research Institute (north Jersey branch of the New Jersey station), which will greatly aid in carrying out the extensive dairy-research program of the institute, including pasture management, nutrition investigations, breeding, and the control of diseases and parasites of dairy animals.

A sheep barn in the form of an open shed, 102 by 34 feet, was built at the Middle Tennessee station at Columbia, for use in experimental work in breeding.

A greenhouse costing about $600 was built at the Vermont station for various experimental purposes.

The new forest-products laboratory building, erected at the University of Wisconsin at a cost of $800,000, was occupied, releasing considerable space for the needs of the various units of the College of Agriculture and, incidentally, increasing facilities for the work of the station.

Improvements at substations in general were very limited in scope, and in only one or two instances were there important additions to land and buildings. In many cases outlying work of the stations was abandoned or drastically curtailed.

For further details regarding expenditures for permanent improvements and equipment, see pages 67–73.

COORDINATION AND COOPERATION

That part of the agricultural appropriation acts authorizing payment of the Hatch, Adams, and Purnell funds to the experiment stations has carried from year to year, for many years, a provision that the Secretary of Agriculture shall "coordinate the work of the Department with that of the State agricultural colleges and experiment stations." Machinery has been set up which is operating effectively to encourage and promote coordination and cooperation between the Department and the stations. Through the Office of Experiment Stations, representing the Secretary in the administration of the Federal funds for the experiment stations, in association with the Director of Scientific Work of the Department and a standing joint committee of the Department and the Association of Land-Grant Colleges and Universities on projects and correlation of research, definite and formal provision is made for developing coordination and cooperation and the principles which should control in the cooperative relations between the Department and the stations. A special committee of State experiment station directors has been making a study of State and Federal relationships in research and reporting with recommendations to the directors at their annual sessions during the past 2 years. The almost constant contacts maintained by the Office of Experiment Stations with Department and station administrative officers and specialists through examination of research projects and programs, conferences, and correspondence is doing much to develop details of effective coordination and cooperation.

Coordination of agricultural research conducted by Federal and State agencies was somewhat unsettled during the year, due to reductions in the State financial support for the work and to the uncertainty regarding the amount of financial support which would be available during the year from both State and Federal sources. For the year as a whole, however, the organization and administration of cooperative research appeared to represent progress along constructive lines, the obvious purpose being greater economy in the use of research funds and the maintenance of the same standards of efficient service if possible. There was a strong effort to

maintain the mutually helpful relations between Federal and State agencies, although these were broken down partly, or wholly in some instances, where financial support was either seriously curtailed or removed entirely.

The advantages, both in ultimate service rendered and in reduced cost, of well considered and carefully planned cooperation and coordination appeared to be more fully recognized than ever before. This was true between research institutions to a marked extent and appeared to have taken its most drastic and effective form within individual experiment stations. There was a tendency toward the greater pooling of research finances, equipment, and personnel within individual experiment stations in the attack on the more important problems confronting the stations. This tendency to conserve and make more efficient use of resources was a recognition of the fact that each of many of the most important problems confronting the experiment stations is a responsibility of the station concerned as a whole and requires the active cooperation of specialists in several lines for its complete solution. It also has emphasized the fact that centralized control and manipulation of research facilities and equipment, if properly exercised as a service to research, tends to conserve the time and energy of the workers, increases the efficiency of the work, and hastens the practical solution of problems under investigation.

Outstanding examples of administrative coordination are the centralized and controlled services of statistics, field-plat equipment and technic, chemical, physical, and optical equipment and technic and the like at several of the stations. The centralized statistical and field-plat control services have proved themselves of wide utility within individual experiment stations and have resulted in improvement in research operations. The development of chemical and physical technic by centralized services to meet very special and exacting requirements of research has resulted in conserving the time and energy of research workers where practiced and has hastened the solution of crop and animal problems.

Determination by individual research institutions to continue to render as great service to agriculture as formerly, in spite of decreased funds and facilities, was reflected also in the national program of cooperation in agricultural research. A total of 802 cooperative undertakings in agricultural research in which the Department of Agriculture and the experiment stations took part during the year was recorded in the Office of Experiment Stations. This was only 61, or 7 percent, fewer than during the previous year. This small decrease in number of cooperative agreements is only natural in view of the curtailment of financial resources available for research. It moreover indicates completion of several studies and consolidation and strengthening of others. Also it relates only to numbers of agreements and is not necessarily indicative of financial curtailment.

All but two of the stations cooperated with the bureaus of the Department during the year, the number of cooperative agreements per station ranging from 2 to 40. Five stations had between 30 and 40 agreements, 12 had between 20 and 30, 18 had between 10 and 20, and the remaining 15 had less than 10. These agreements were distributed by subject as follows: Improvement of quality and lowering the cost of production of cereal, forage, textile, and other field crops and fruit and truck crops, improvement of pastures and ranges, and combating crop-plant diseases, 304 as compared with 334 the previous year; agricultural economics, farm management, and rural sociology, 127 as compared with 143; improvement of animal products, especially meats, combating animal diseases, and improving the breeding of animals, 82 as compared with 92; soil surveys, improvement of soil fertility and productiveness, and fertilizer development and improvement, 62 as compared with 70; combating insect pests of plants and animals, 75 as compared with 74; introducing greater efficiency into agricultural production operations by adapting engineering principles, 65 as compared with 68; improvement of dairy stock and products, 37 as compared with 36; improvement of timber crops, combating forest-tree insects, and forest maintenance, management, and reseeding, 29 as compared with 29; improvement of human foods and of food-management practices, 13 as compared with 9; maintenance of

economically important wild life and combating animal pests, 5 as compared with 5; and studies of weather conditions important to agriculture, 3 as compared with 3 the previous year.

Lines of work in which cooperation between the stations and the Department was most prominent and extensive during the year included: Surveys of soil resources in localities representative of practically every major agricultural area in the country; soil use and conservation; establishment of superior types of farming; prevention of soil losses through erosion; improvement of irrigation practices; development of utility and economy of concentrated fertilizers; improvement of fertilizer practices with potatoes on prominent soil types; development of machine placing of fertilizers for corn, cotton, potatoes, and canning crops; improvement of corn and other cereal crops; studies of how cotton grades and prices may be improved; breeding of improved varieties of potatoes resistant to disease; development and establishment of type varieties of vegetables; development of use of parasites to combat the oriental fruit moth; survey of plant diseases; increasing the efficiency of oil sprays for combating insect pests; improvement of conditions of livestock production, marketing, and meat utilization in areas released from cattle tick quarantine; improving the quality and palatability of meat; determining the features of conformation and anatomy of the dairy cow important to productive ability; development of beefiness and milk production in dual-purpose cattle; development of use of proved sires in breeding for high milk and butterfat production; prevention and eradication of contagious abortion of cattle; establishment of a farm real-estate tax index; and a survey of the economic and sociological conditions of the Appalachian Highlands area.

Cooperation between the stations and Department bureaus in agricultural research is thus being maintained to solve important national and regional problems in such a way that the stations can make adaptations of the results to meet local requirements satisfactorily. This cooperation is not only coordinating the efforts and facilities of the interested research agencies to a high degree but is stimulating the most efficient use of research facilities, finances, and personnel in individual research institutions.

Wasteful duplication of work is sometimes charged against the stations, but when the great variety and range of conditions and problems with which stations have to deal is considered, it is difficult to name specific cases which can without qualification be called undesirable or unwarranted duplication. There are, on the other hand, many examples of necessary repetition and verification under varying environmental and economic conditions, as well as a large and increasing number of local emergency and service calls which the stations must meet. Much that might seem on superficial examination to be unnecessary duplication is in reality very important if the results of scientific research are to be fully and usefully applied in practice.

It is generally conceded that effective coordination and cooperation must begin "at home", that is, with the internal organization of the station, and then become local, regional, and national, as the nature of the work may warrant. Many problems need especially the coordinated effort of various specialists, particularly under emergency conditions. It is evident that this is the course that coordination and cooperation in agricultural research is now taking.

RESEARCH PROJECTS AND PROGRAMS

As indicated in other parts of this report, there was unusual activity during the year in revision, readjustment, and coordination of station projects and programs. This was clearly reflected in the new and revised projects submitted to the Office of Experiment Stations for examination, possible improvement, and approval. The stations continued to give much attention to revision of their research projects and programs to adjust them to actual and prospective reductions of income and to make them meet more fully local emergency needs and calls for assistance, at the same time contributing effectively to the broader national policies.

A total of 433 Adams projects, dealing primarily with fundamental research, and 1,437 Purnell projects, somewhat broader in plan and purpose and providing specifically for research in economics, sociology, and home economics, as well as in production, besides a large number of projects supported by Hatch, State, and other funds, were examined. The Adams and Purnell projects were distributed by major objectives and allotment of funds as shown in table 3.

TABLE 3.—*Distribution of Adams and Purnell projects by major objectives*

Item	Projects		Amount expended 1932–33	
	Adams	Purnell	Adams	Purnell
Improvement, more economical production, and better utilization of plants and plant products:				
Improving quality, disease resistance, and hardiness by breeding	*Number* 53	*Number* 91	$93,570	$173,164
Protection against insects, plant diseases, and rodents	137	195	166,210	274,721
Conservation, maintenance, and management of the soils and crops	83	261	156,729	532,929
Improved methods of handling, storing, utilizing, and marketing of plant products	16	148	32,791	268,727
Physiology of growth and fruiting	30	47	55,038	78,909
Improvement, more economical production, and utilization of farm animals and animal products:				
Development of improved animals by breeding	18	24	27,783	41,567
Feeding and management for more economical production	44	181	98,073	417,016
Protection against diseases and parasites	44	66	84,727	118,674
Efficient handling, processing, and marketing practices	7	133	6,760	249,380
Physiology of growth, reproduction, and milk flow	1	19	2,500	37,963
The betterment of the family, the home, and the community:				
Physical improvement of the family through new knowledge of food composition, improvement in food preparation, analyses of dietary practices, development of new standards, and fundamental discoveries concerning factors affecting growth, nutrition, and health	----------	48	----------	117,875
Betterment of the home through information on household equipment and its arrangement and efficient use, factors affecting the selection and care of clothing and textile fabrics, methods and standards of household buying, consumption habits and standards, possibilities of contributions of homemakers to family income, and factors determining standards of living in various sections of the country	----------	51	----------	118,172
Social organization and improvement	----------	36	----------	74,260
Population movement and changes	----------	9	----------	13,862
Farm business improvement:				
Taxation	----------	24	----------	53,980
Land utilization	----------	15	----------	46,759
Financial relationships—tenancy, mortgages, investments, adjustments	----------	14	----------	29,680
Business organization and cost	----------	54	----------	140,501
Marketing organizations	----------	21	----------	45,094
Total	433	1,437	724,181	2,833,233

Classified with reference to technical fields covered, the Adams and Purnell projects were distributed as shown in table 4.

TABLE 4.—*Distribution and support of Adams and Purnell projects by major subjects*

Subject	Adams projects			Purnell projects		
	Number	Allotment of funds		Number	Allotment of funds	
		Adams	Other		Purnell	Other
Plant physiology	28	$55,640	$20,700	17	$30,772	$11,315
Soils and fertilizers	58	97,984	17,411	79	190,119	20,290
Field crops	16	31,443	4,843	85	176,616	18,947
Pastures and ranges	9	18,820	725	25	39,145	4,275
Horticulture	33	65,718	15,950	128	202,507	22,225
Forestry	3	5,660	----------	5	8,230	----------
Entomology and zoology	54	56,792	20,162	101	146,803	30,931
Plant pathology	86	101,059	39,520	106	135,781	24,714
Genetics:						
Plant	34	55,041	33,162	27	56,835	22,223
Animal	12	19,210	10,200	15	23,542	4,215
Animal production	45	103,504	31,078	201	422,287	117,250
Dairying	10	9,238	8,860	27	35,636	13,600
Animal diseases	37	63,987	45,445	55	104,531	32,523
Agricultural chemistry and technology	11	17,446	9,130	17	28,814	5,375
Agricultural engineering	4	8,240	----------	63	103,343	10,113
Agricultural economics	----------	----------	----------	327	750,415	99,082
Rural sociology	----------	----------	----------	52	110,458	13,005
Home economics	5	9,550	5,385	134	263,425	26,127
Total	445	719,332	262,571	1,464	2,829,259	476,210

TRENDS IN RESEARCH AT THE STATIONS

Out of the broad program of national endeavor to restore rural prosperity is arising the most urgent demand for modern scientific research ever made upon agricultural institutions. The Nation is coming to realize more clearly than ever before that in each stage of advancement, efforts to improve agriculture and rural life must be guided by a higher order of rural intelligence than prevailed in the stage preceding. Developing the factual basis for this improvement in thought as a guide to rural achievement is primarily a task of the agencies of agricultural research.

This enhanced demand is exacting as to both the soundness of research performed and its bearing upon human economic and social objectives. In keeping with these requirements, an increasing number of agricultural research programs, participated in as a rule by State and Federal agencies and requiring a diversity of scientific talent representing both natural and social applications of science to agriculture and rural life, have been initiated in recent months. Examples of such programs are the agricultural-adjustment program of the Illinois station, the economic and social study of the southern Appalachian Highlands by the State stations of that area, and the land use and planning programs, suggested by the committee on projects and correlation of research at the 1932 convention of the Association of Land-Grant Colleges and Universities, sponsored by the executive committee of the Association and the National Land Use and Planning Committee and initiated in Georgia, Minnesota, New York, Pennsylvania, Wisconsin, and a number of other States.

The research phase of the Illinois agricultural-adjustment program is especially interesting at this time. It is a scientific approach to the development, organization, and administration of a balanced program of research designed to help the rural people of the several type-of-farming areas of the State to advance economically, intellectually, and socially. In this critical analysis and synthesis of agricultural research in the light of the needs of rural people, the director is the leader and his staff of scientific specialists are his associates. It is hoped that this project will yield information concerning research administration of value throughout the country.

The economic and social study of the southern Appalachian Highlands was undertaken in the hope that the results obtained would enable agricultural, educational, and religious leaders to understand more fully the conditions surrounding the people of this area, and to develop a coordinated program for economic and social betterment.

The research programs in land use and planning are fast approaching national proportions. They are designed to secure the appropriate use of all types of land and to show how to get lands submarginal to crop production out of cultivation and into grass, forests, recreational uses, or to whatever use they may be suited.

Another field, hardly entered into but in which there is a growing interest, is the study of the sociological effects of the interactions of urban unemployment, agricultural distress, and land settlement.

These more extensive demands for agricultural and rural-life research, coming as they did concurrently with, in most cases, drastic curtailment of supporting funds, the question might well have been asked earlier in the year whether the State agricultural experiment stations could adjust themselves to their new responsibilities in connection with State and National programs of agricultural adjustment. That the stations have met the situation confronting them with remarkable promptness and vision is borne out by their records of performance for the year now closing. With budgets reduced, and surrounded by many uncertainties, the directors have readjusted salaries, expenses, personnel, projects, programs of research, and Federal cooperative relations with little lost motion and, everything considered, measured up fully and well to the agricultural emergency.

How these research agencies have adapted themselves to changing demands for the services of research over the years is best explained by illustrations from their records. Clearly the stations were created for farmers in response to farmer demands. In proportion as the stations have enjoyed the encouragement and support of rural people and the public generally, they have never failed either to respond to the expressed demands of rural people for immediate service or to anticipate their prospective or

potential needs. As the farmers evolved and the nature of their problems changed, so did the stations evolve and change in scope and function.

Records of the Connecticut station are very instructive for the light they throw upon the relation between farmers and agricultural research from its beginning in the United States to the present time. In the introduction to the first annual report of this station, it is stated that "We deem it pertinent to remind the farmers of Connecticut that this institution is theirs exclusively. It was brought into existence in response to their demands. It is at work for them." The same might have been said of practically every other State station. From that day to this the compact between rural people and research specialists has never been broken; but has grown stronger with the years. Progressive farmers gave the stations encouragement and support in return for truths discovered or established.

That the function of the stations was scientific research, W. O. Atwater, the first director of the Connecticut station, took the pains to explain to Connecticut farmers in a preliminary report issued in May 1876. He said: "Scientific investigations * * * afford not only the proper, but also the most widely and permanently useful field of labor" for a station. Recognizing, however, that farmer confidence was the first essential to the success of a station, and that this depended upon the ability of the station to provide emergency information and services when demanded as well as to conduct scientific investigations which anticipated the prospective needs of the farmers for new types of information, the director explained that—

> The need of a fertilizer control system was so pressing and so vital to the interests of a considerable portion of the farmers of the State that it seemed absolutely necessary to turn the first efforts [of the station] in this direction. * * * The analysis of fertilizers is by no means the most important work [however] of an agricultural experiment station. Such an institution will be worthy of the name in proportion as it carries on accurate and thorough investigations and experiments in agricultural science. * * * This is simply in accordance with the fact that the knowledge of any principle is of more consequence than any one special application of it. It is important for the farmers of Connecticut to know whether they get the worth of their money in the manures they buy, but is of equal consequence that they should know how to use them. And it is of still more importance to them to learn how they shall manage their fertilizers, their crops, their fodder materials, and their stock, so as most economically and profitably utilize the products and the productive power of their farms.

In the early days, when farmers were concerned primarily with matters of production, as were their forefathers through the ages before them, the stations rendered the types of service then required. They began, much as did Connecticut, by making analyses and tests of such items of interest to farmers as soils, fertilizers, field crops, fruits, vegetables, feeding stuffs, seeds, fungicides, insecticides, and crop rotations, but they did not stop at this stage. As scientific men, the pioneers in agricultural research felt that, with the evolvement of the sciences themselves, it was the duty of the research agencies to go further than merely to satisfy the immediate requirements of service to farmers. They felt that the most important function of these agencies was to anticipate and interpret with vision the rural needs of their respective States and to apply all the forces of science to the less apparent but more complex problems of agriculture and rural life.

The records are clear, therefore, that from their small beginnings the stations had as their main objectives the lifting of the physical burdens of farm and rural life, the improvement of farm and farm-family incomes, and the elevation of rural life to a plane consistent with national aims and aspirations for progressive advancement. Accordingly, the records show that between the seventies, when the first agricultural experiment stations were established, and 1900, the stations were rendering American agriculture a constantly improving service, more significant to farmers than were mere analyses and tests. More and more, they resorted to a division of labor, or intensive specialization, to improve the skill and dexterity of research specialists. They were developing talent, improving the methodology essential to sound research, and studying many problems that were difficult not only to solve but to visualize or evaluate. Examples are tick fever of cattle, hog cholera, cotton root rot, sugarcane mosaic, sore mouth of sheep, and many others.

In this period, prior to 1900, the natural sciences were evolving and agricultural physics, engineering, and chemistry, botany, entomology, veterinary science, agronomy, horticulture, animal husbandry, plant and ani-

mal breeding, physiology, and pathology, were being applied to the technical problems of agriculture in accordance with the expressed demands of farmers for the passage of State legislation to promote the economic and social progress of rural people.

The year 1900 marked an important turning point in the history of both State and Federal research agencies. About that time the investigation of the economic, as contrasted with the technical, problems of agriculture, had its beginning. In Minnesota, it was cost accounting viewed as a means to the end of adjusting farm operations so as to secure better incomes. In Wisconsin, it was agricultural economics. At Cornell University and in the United States Department of Agriculture, it was farm management. It is interesting to recall that the men who conceived these new types of investigation were originally either technical specialists on a station staff, such as Hays, Boss, Spillman, and Warren, or farm-reared boys like Taylor, Hibbard, and Carver, who studied economics in the universities to enable themselves to answer some of the questions in agricultural economics raised by stump speakers during the depression of the nineties. With few exceptions, economists prior to the beginning of this century either saw no farm-economic problem or had very little interest in it.

Since 1900, farm management and agricultural economics have made a phenomenal growth which still continues. Investigations in these fields during the past generation have had much to do with the creation of present-day demands for rural social justice. Until the rise of burdensome surpluses of farm commodities after the World War, farm management and agricultural economics had amounted to little more than studies in the economics of production and marketing; but since then agricultural economics has dealt more and more with problems of exchange, distribution, and consumption.

Beginning about 1900, also, but developing more slowly, another subfield of social science was added to station research programs. This phase, rural sociology, notwithstanding its slower progress, has doubtless contributed much to what might be termed the humanization of socialization of agricultural research. Sociological research in agriculture and home economics received impetus from the Purnell Act in 1925 and, since that date, this field has made remarkable growth, the time considered, in an appreciation of its problems, the development of research methodology, the interpretation of data, and the publication of results. Sociological projects are now conducted by about one half of the State stations and by the Bureau of Agricultural Economics. Almost coincident with the development of agricultural economics and rural sociology, another field—home economics—dealing at once with all the problems of the rural home, whether physical, biological, economic, or sociological, has been evolved and added to station research programs. These three fields—agricultural economics, rural sociology, and home economics — have contributed enormously to the health, comfort, happiness, and intellectual and social advancement of rural people.

This new trend of development in agricultural research was of more than ordinary significance. The social sciences not only rendered immediate practical service to American farmers and farm homemakers, but were enabled also to look far ahead toward the satisfaction of the prospective and potential needs of farm people in their struggle for progress. Valuable teamwork between the natural and the social sciences was initiated. It was in consequence of this that the Nation's agricultural research agencies, State and Federal, were able so promptly and well to meet the additional responsibilities cast upon them by the emergencies of agricultural adjustment even at a time when they were seriously weakened financially.

Another trend in evidence is the lessening differentiation between the natural and social sciences. More and more these two types of science are coming to be recognized as but parts of a universal science. It is seen that any science is social to the extent that it contributes to human welfare, and insofar as it is sound in the processes of reasoning involved it is natural science. Increasingly, therefore, these two branches of science are becoming as one in an effort to advance rural people economically and socially.

Viewed from another angle, these united sciences will continue to solve problems pertaining to production but these will be studied relative to exchange, distribution, and consumption of wealth. With the passing of time, the prevailing knowledge of production will undoubtedly be balanced by

greater advances in the knowledge of physiology, chemistry, economics, and sociology of consumption.

It is hoped that research will point the way to a better-balanced individual and national economy and more substantial advances in civilization. Many of the questions now confronting the country will doubtless be obviated. Research will be asked to determine and help to secure a parity between rural and urban prices, incomes, standards of living, and opportunities for human advancement. Research will also be called upon to make clear to the Nation just what American urban population owes to the rural districts for their raw products, their wealth, and their sons and daughters, which flow to the cities, add to their progress, and contribute much to the leadership in industry, trade, the professions, and government, and thus play a vital part in national advancement.

SOME RESULTS OF RECENT STATION WORK

The following review, prepared from current publications of the stations and communications from station directors, attempts simply to present a few examples of station work in terms of major objectives and special significance at the present time.

The examples cited deal mainly with land use and conservation, crop adjustments, plant and animal production and dairying, farm business management and finance, rural-home and rural-life betterment, and special service work.

The review is necessarily selective. It is not a complete summary of all recent accomplishments of the stations as a whole, or individually. Many other equally significant examples of station work might have been included. It is hoped, however, that the review will serve to indicate especially the economic importance of the work of the stations, and to show that it is of value to urban as well as rural people and in line with national as well as local relief measures and policies.

LAND USE

A major concern of American agriculture at the present time is to find more efficient ways and means of using land and of adjusting production, both quantitatively and qualitatively, to consumption. To the solution of this problem, many of the experiment stations are making noteworthy contributions, as the following examples may serve to show.

Soil classification.—A necessary basis for intelligent land use is a knowledge of the character and crop adaptations of the soils to be dealt with. This important information is furnished in large measure by the soil-survey and associated work of the experiment stations and the Department of Agriculture.

Soils have been and are being studied and classified on an extensive scale, and their crop adaptations determined under widely varying conditions. A new impetus has been given to such work and its value is being more fully appreciated because of its essential bearing on the national policy of restricting cultivation to the best lands, utilizing the less productive land for pastures, forests, parks, and the like, with the attendant problems of crop adjustments on a national scale and the best use of the lands thrown out of cultivation.

The soil-survey and land-utilization studies.—Soil surveys made by the experiment stations, in most cases in cooperation with the Department, furnish a basis for some of the most effective work on land use and crop adjustment.

Soil surveys now completed in over half of the 102 counties of Illinois are being used effectively to speed reforestation and other forms of land utilization. The director of the experiment station says of this work:

> Illinois already has plans well under way for two national forest units involving 599,232 acres in southern Illinois. These plans would not be so far along were it not for a long-established project like the soil survey. Facts collected in the survey were used for blocking out these two units, and when the preliminary report was sent to Federal forestry officials they proclaimed it the most complete one they had ever seen. If these national forest units materialize, they will be included in President Roosevelt's national reforestation program, they will employ hundreds of men in southern Illinois, they will take thousands of acres of marginal and submarginal land out of production, they will relieve the counties and the State of maintaining roads and schools in the area, and the money that the counties will receive from the forests will mean far more than what they would ever have realized from taxes.

Data obtained by the New Jersey Experiment Station from the complete and detailed soil survey of that State and from intensive studies of soil and crop adaptations furnish a valuable basis for effort to secure the most profitable use of land under the highly specialized agriculture of that State.

Use of idle lands.—Reduction of the area under cultivation in Massachusetts has resulted, as the experiment station points out, in an important and pressing problem in utilization of the idle lands. The station states that although a considerable part of the present area of such lands may be taken up in the near future for part-time farming or recreational and residential uses, the major part of it must be utilized for forestry purposes. At the present time about 15,000 acres of land are in State forests, 25,000 acres in town forests, and small areas in forest land held by various public and semipublic organizations. The station strongly urges increased use of the land for recreational and forestry purposes. (See also p. 35.)

Shifting to pastures.—An obvious use of land thrown out of cultivation is for pastures. Fear has been expressed that such a shift on the large scale now proposed would tend unduly to increase production of meat and milk, but this fear seems to be groundless because, as pointed out by the Department of Agriculture, pasture crops, even when fully utilized, produce far less feed per acre than harvested crops. Records obtained from different parts of the country "show conclusively that land in harvested grains and forage crops produces at least twice as much livestock feed as land in pasture", and indicate that many dairy farmers "would find it advantageous to change their system of farming to one in which they would keep most of their land in permanent pastures and legumes and feed very little if any grain."

Experiment stations in States having extensive areas of idle lands are actively engaged in finding the most economical ways of improving them and utilizing them for pasture purposes. The Massachusetts station has shown that stony upland pastures can be profitably improved with a relatively small outlay for fertilizers. The Connecticut (Storrs) station has developed a system of pasture improvement which is being adopted throughout the State. Progressive ranchmen of Hawaii have been enabled to improve their ranges on the basis of information regarding improved grasses and other forage crops and the best methods of propagating and maintaining them furnished by the Hawaii station as a result of many years' cooperation of the station with the Department and ranchmen. (See also pp. 25, 35.)

Some local features of land utilization.—From a study of land utilization by the Arkansas station, cooperating with the Southern Forest Experiment Station, the conclusion was reached that much of the land in many areas is better suited to growing timber than to farming. In many instances farming should be abandoned on entire farms; at least timber raising would be just as profitable. Owners have been unable to pay taxes upon much of this land and it is subject to reversion to State ownership. As it is acquired it should be scrutinized very carefully as potential State-owned forest land, for much of it is best adapted to this end. Land-use studies by the Georgia station, cooperating with the Department, in selected counties in the lower Piedmont area of the State have given information regarding idle and abandoned farm land, type of soil and extent of soil erosion, forest growth and forest cover, type of land ownership and type of tenants, taxation and other related subjects bearing on the best use of farm lands, and interest in continued ownership and operation which it is thought will enable the State to set up new agricultural programs in this area where much of the land has been abandoned.

Studies of conditions in certain areas in Kentucky by the Kentucky station have shown that a great part of the land is unfit for agricultural use and could be used to better advanatge in some other way. The consolidation of many of the poorly utilized and managed tracts into large forest tracts under private or public ownership is needed. Enlargement of forests into good-sized tracts would make possible more adequate protection against fires, the application of greater skill in the care of the growing trees, and the more economical harvesting of the timber. An effort should be considered to devise plans whereby farmers on submarginal farms might have an opportunity to shift to better farming lands.

A study of land utilization in northern Minnesota by the Minnesota station has led to a land classification plan, with recommendations to the State executive, for ultimate land use in this section of the State. The station is also participating actively in soil-erosion-control studies and demonstrations in the rolling lands of southeastern Minnesota. As a result of these studies and of investigations by the station, much unproductive peat

and bogland of the State is being converted into good pasture and hay land through the use of reed canary grass. The popularity of this movement is attested by the frequent inquiries for seed and instructions for establishing the crop. It is stated that Minnesota has 7,000,000 acres more of peat lands than any other State. To show how these lands may be used to the best advantage, how they should be handled, and the crops best suited for them is a matter of no little economic importance.

Cooperating with the Department, the Nevada station is making classifications of land and studying land use on farms of the Walker River Irrigation District to obtain information to be used in adjusting the finances of districts which would otherwise fall into insolvency and financial ruin.

A study of utilization of land in Vinton County, Ohio, by the Ohio station, showed that 41.2 percent of the total land area was not included in farms. Moreover, 25.8 percent of the area of the county once included in farms now lies idle. It was also found that the net amount of public funds going into the county from the State and Federal Government over a 10-year period would equal the present value of the farm land. The conclusion is that large areas of the county could best be used for other than agricultural purposes.

The future economic use of land in Rhode Island is being studied by the Rhode Island station. The studies include soil surveys in cooperation with the Department, a land-cover survey to determine present uses of land, a survey of local farm-management methods, and observations on climatic conditions as affecting land use. The studies are expected to provide basic information which can be used in present and future schemes for reforestation and back-to-the-land movement, and in determining areas suitable for subsistence farming.

The Wisconsin station, among others, has entered upon a systematic program of land-utilization adjustment of far-reaching significance.

ADJUSTMENTS IN FARM PRODUCTION

Adjustments in farm production and cropping systems to meet varying economic conditions is a fruitful subject of investigation by many of the experiment stations.

Adjusting cost of production to new price levels is difficult, and the Kentucky station has found that the average Kentucky farmer is not succeeding very well in doing it. However, the station found farmers in every area of the State studied who were making the adjustments successfully. Comparing high-income with low-income farmers, the station shows that—

> the labor income of the 10 farmers procuring the greatest income was $546, while the 10 lowest farm incomes had a labor and management wage which averaged —$494. The farms of high income excelled the low-income farms in labor accomplishments per man, in crop yields, in livestock production, in the number of cows, and in the acreage of tobacco per 100 acres of land. These factors of superiority were principally responsible for the relatively high returns of the farms.

The results of studies of farm organization and management by the Minnesota station have proved especially valuable in making adjustments in farm production. The data obtained have been promptly utilized by extension specialists and farm-management specialists in modifying the production programs on many farms. It is stated that there is no question but that production efficiency in this State is rapidly improving as an outgrowth of these studies. Basing their actions on the information supplied, many of the best farmers of the State are replacing widely grown surplus crops with those for which the demand is still high. Much of the less productive land is being included in pastures or in meadows where the expense for operation is nominal.

Emergency farm-adjustment problems are receiving special emphasis at the South Dakota station. The station has recently published a report on Emergency Farm Adjustments in the Wheat Areas of South Dakota, which shows actual conditions on farms in this area and indicates means of improving them.

The economic soundness of a balanced agriculture has been demonstrated by the Ohio station. Applying the results of the station's findings, the farmers of the State have been able to make adjustments in farm management which have enabled them to withstand the depression somewhat better perhaps than those who have depended on a single-crop system.

Much that many of the stations are doing appears to have an important influence in bringing about the economically balanced agriculture so essential to relief of present depressed conditions and to be in line with the

advice given North Dakota farmers some years ago by H. L. Bolley, botanist of the station in that State:

> Don't plant more of anything. Plant less. Raise enough of high quality on less acres. Let Mother Nature have some wild life.

(See also p. 39.)

PLANT PRODUCTION AND USE OF PLANT PRODUCTS

GENERAL

The primary object of a large part of the work of the experiment stations is the more economical production of a commodity that will command a better price. Efficient production is and must remain a basic concern of agricultural research and of the farmer it is designed to help. It is fully as important as profitable sale of the product and beneficial use of the proceeds. The director of the Maine station says:

> We maintain that we cannot lose sight of the production problems. It is important to produce as cheaply as possible. If one cannot produce as cheaply as his neighbor he is lost before he gets to the market. Marketing studies are essential but production problems should not be neglected in order to carry on marketing studies.

Reducing cost of crop production.—In a study of means of reducing the cost of production of the staple farm crops, the Pennsylvania station found that the power and labor required in producing crops amount to more than 50 percent of the total cost. By the use of the general-purpose tractor, and special equipment designed or adapted by this station, corn was produced at a cost of $10 an acre, as compared with the average farm cost of $25; similar results have been secured with potatoes.

Variation in return from the same crop on different farms.—The study by the Maryland station of the organization and business analysis of nearly 600 representative Maryland farms showed not only a wide variation in returns from farms majoring in different crops, but also a wide variation in the returns from farms majoring in the same crops. Many of the farms were producing a satisfactory return on the investment. The 3-year average for 144 dairy farms yielded 4 percent net on investment, and 36 of the list of the dairy farms gave a net return of 13.25 percent on the investment. Thirteen of the most profitable general farms earned 10.6 percent on the investment. The 4 most profitable livestock farms yielded 5.8 percent on the investment. Profitableness was associated with (1) size of business, (2) crop yield and animal production, (3) efficiency of operation, and (4) selection and combinations of crops.

SOIL CONSERVATION AND IMPROVEMENT

Prevention of soil erosion.—According to a statement recently issued by the Department of Agriculture, soil erosion has already destroyed for crop production 35,000,000 acres of land in the United States formerly used for cultivated crops, and caused serious damage to 200,000 additional acres. The annual cost of the damage done by soil erosion and attendant injuries is estimated at not less than $400,000,000.

In cooperation with experiment stations and other State agencies, the Federal Government is studying the subject of erosion control on an extensive scale to find means which can be widely applied for protection against further ruin of about a million acres of naturally good land which is washing away and losing fertility at an alarming rate. Erosion projects have been set up in representative localities in different parts of the country, and soil-erosion control has been made an important feature of the work of the Civilian Conservation Corps in Alabama, Illinois, Indiana, Iowa, Kentucky, Minnesota, Mississippi, Missouri, Ohio, Oklahoma, Tennessee, and Wisconsin. The latter, however, is a large-scale demonstration applying such information as is now available and does not attempt work of a strictly research nature. It includes terracing, dams to control flood water, planting trees and soil binders, and the like, and is being done in cooperation with various bureaus of the Department and State agencies.

The efficiency of terracing to check soil erosion has been demonstrated by the Department and many of the experiment stations. The Missouri station has found that a good cropping system which leaves the soil bare as little as possible is a material aid in controlling erosion on both terraced and unterraced soil.

Studies of erosion by the Alabama and Texas stations show that terraces, while necessary on all cultivated land subject to erosion, are not alone sufficient to protect against serious losses of soil between terraces. Even with terraces large quantities of the finer, more fertile portions of the

soil, as well as much needed water in the drier regions, are lost by sheet erosion and run-off. The stations have shown that this loss may be reduced materially by strips of cover crops planted as a supplement to the terraces. Results of field trials by the Alabama station indicate that this method of soil and crop management does not materially increase labor or power cost and is adapted to soil-building practices recommended to farmers by the station.

In cooperation with the Department, the Iowa station has been making studies of soil erosion and its prevention on the Marshall silt loam, the major soil type in the loess area of Iowa. It was found that the average farm in that part of the State is being washed away at the rate of 1 foot in 50 years or less. This loss results largely from sheet erosion. When corn is grown continuously, the loss takes place at the rate of 1 foot in 36 years, at least. Where the corn rows run across the slope, the losses are cut in half. Losses under clover, alfalfa, and bluegrass are very small. Under a rotation, losses would undoubtedly be much less than under corn continuously. With treatments of manure the losses by erosion were reduced one half. When sweetclover was plowed under, the losses were still more strikingly reduced. In many cases, combinations of dams or of terracing with treatments of the soil and proper cropping systems seem to be the best way to control or prevent erosion.

The director of the North Carolina station says: "The annual loss in fertility and yielding power of North Carolina farm lands due to soil erosion is more than $60,000,000." Recent cooperative studies with the Department and independent studies of the station indicate that much of this loss can be prevented by changes in the usual cropping system and proper terracing. Revised cropping systems under experimental conditions over a period of years have checked erosion, maintained soil fertility, provided a better distribution of labor, and given a higher net farm income.

Studies of soil erosion by the Washington station cooperating with the Department have shown that the topsoil is gone from more than 20 percent of the area on the experimental soil-erosion farm in that State, which is representative of large areas in eastern Washington. Winter wheat yielded from one tenth to one half as many bushels per acre on lands which had lost the topsoil because of erosion as on lands which still retained the top layer. The yields of spring wheat from eroded areas were even less favorable than those of winter wheat, and peas and potatoes grown on eroded soils produced exceedingly small yields. In a study of the effect of vegetative cover on soil erosion it has been demonstrated conclusively that vegetation, whether of grasses, legumes, or grain stubble, very largely controls soil and water losses.

Maintenance of soil fertility.—As a result of many years' observations and investigations on possibilities and methods of maintaining soil fertility, the Missouri station reaches the conclusion that without question the farmer has it in his power to check excessive soil exhaustion and keep soil fertility at a satisfactory and more or less constant level by practicing systems of crop rotation and use of manure and avoiding the unnecessary and excessive loss of soil fertility such as occurs in continuous grain farming.

Forecasting water supply.—In regions of deficient rainfall the amount of snow on the mountains is a measure of the water supply for power, irrigation, and other purposes during the coming season. Snow-survey methods perfected by the Nevada and Utah stations have furnished a practicable and very useful means of measuring the snow cover and predicting the available water supply. A network of snow-survey courses established by the Utah station in the high watersheds of the State is serving as a basis for determining the run-off for each watershed and forecasting the stream flow. Wide practical use is also being made in this way of the snow-cover survey methods worked out by the Nevada station.

Measurement of irrigation water.—For regions dependent upon irrigation, the development by the Colorado station, in cooperation with the Department of Agriculture, of accurate methods of measuring and distributing water is especially significant and important. Out of this work have come methods and appliances, far superior to any others previously in use, which are being widely adopted in practice to the great advantage of irrigation farmers and water companies. This station has developed a type of sand trap to catch the sediment, particularly sand and gravel, in the irrigation ditches, which is being tried in various sections of the State. One of the designs has proven a success and

has been installed in several canals and laterals. It has been shown that large savings can be obtained by the use of this trap in keeping ditches free from wash or sediments.

Soil penetration of irrigation water.—The ability of the farmer to get uniform and complete soil penetration of irrigation water, which is one of the most important problems in southwestern agriculture, has been shown by the Arizona station to depend largely upon soil structure. By utilizing the uniformity of air movement through soils, "structure constants" have been obtained by the station which have proved to be reliable indicators of permeability and the possibility of securing effective distribution of irrigation water in the soil. Another factor closely related to permeability, namely, the salt content of the irrigation water and the nature of the salts present in relation to the movement of water in the soil, is also being studied by the station.

Value of legume inoculation.—It is estimated that the general use of legume inoculants recommended by the Illinois station is now saving farmers of that State $8,500,000 annually by preventing alfalfa and sweetclover failures and increasing the nitrogen made available by these plants.

A conservative estimate indicates that 85,000,000 pounds of nitrogen are fixed annually out of the air by the bacteria on these two crops, and nitrogen is one of the readily-depleted fertilizing elements and the most expensive one that Illinois farmers have to buy. From the 85,000,000 pounds of nitrogen fixed annually out of the free air, farmers are reaping benefits in the form of reduced production costs and higher quality products. If they had to pay market prices for this nitrogen, it would cost them $8,500,000 annually, even at present low prices.

Liming.—The action and most effective use of lime as a soil improver continues to be an important subject of study by the stations. From experiments on soils of different kinds, the Missouri station has concluded that liberating and making more available soil potash is "unquestionably one of the beneficial effects of liming."

From buffer and acidity studies of soils, the Delaware station reached the conclusion that Delaware farmers apply about 25 percent more lime per acre than is necessary for most farm crops, and that the judicious use of this information would reduce the annual cost of lime to Delaware farmers by about $50,000.

A method of securing effective legume inoculation by the use of much smaller quantities of limestone than commonly used has been developed by the Missouri station. Small amounts of finely ground limestone, drilled into the soil with the clover seeding, have served in place of the heavier limestone applications. The economy of this method of supplying lime is evident. The reduced amount required per acre lessens the cost at the quarry and the cost of transportation. The finely ground limestone may be drilled into the soil with a common fertilizer drill, eliminating special machinery and reducing the cost of applying. The Iowa station has found that application of finely screened limestone favors effective inoculation and not only increases the yield but improves the quality of alfalfa on acid soils. The limestone was most effective when applied at rates not exceeding 3 tons per acre. (See also p. 24.)

Relation of fertilizers to soil acidity.—The effect of nitrogenous fertilizers on the acidity of a soil is a very important factor in evaluating such fertilizers and the need for lime. Amounts of limestone required to neutralize the acidity developed by certain of these fertilizers have been established by the Alabama station. The station finds that most of the nitrogen used in mixed fertilizers is derived from acid-forming fertilizers such as ammonium sulphate and ammonium phosphate because of their cheapness, and if these are used continuously without liming the productivity of the soils will be reduced. Experiments by the station on sandy soils showed that acid-forming fertilizers on unlimed soils, for a period of years, were less efficient for cotton production than nonacid-forming fertilizers; whereas they were just as efficient on soils which had been sufficiently limed to neutralize the acid produced. In all cases, the plats which received ammonium sulphate, ammonium phosphate, and other physiologically acid fertilizers gave the greatest increase from the use of limestone. It is estimated that Alabama uses only one twenty-fourth as much agricultural limestone as would be required to neutralize the acid developed by the nitrogenous fertilizers used annually.

As a result of 50 years' experiments with nitrogenous fertilizers, the Massachusetts station concludes that ammonium sulphate is equal to nitrate of soda for various crops on recently limed soil.

The effect of fertilizers of different kinds on soil acidity has been extensively studied by the New Jersey station, with the result of showing that not only ammonium salts but other fertilizing materials which are coming into common use affect the reaction of the soil and the growth of crops. The station points out that—

> in the eastern United States where the loss of lime through leaching is heavy and where acid-forming commercial fertilizers are used extensively, it is of the utmost importance that a careful and frequent check be kept on the soil reaction, so that lime may be applied when and where needed.

Preparation of composts. — The New Jersey station has found that by combining plant residues such as straw, high in cellulose and lignin and low in nitrogen and minerals, with residues such as leguminous plants or green materials, low in cellulose and lignin but high in minerals and nitrogenous constituents, a compost can be prepared which will begin to decompose immediately. A good compost was obtained under these conditions after a period of 6 weeks. The station has prepared and distributed instructions for the preparation of artificial composts which can be effectively substituted for stable manure in the growth of mushrooms.

Minor mineral constituents of soils.—The studies conducted by the South Carolina station revealed the fact that on certain soil types and in certain fertilizer combinations various minor constituents of the soil, such as manganese, magnesium, and others, are converted into soluble form and readily leached through the soil, causing a deficiency which seriously retards plant growth and crop production. This condition is widespread in certain sections of South Carolina and causes large losses of truck crops and cotton (in some fields less than 50 percent of the usual crop being produced). After the cause of the trouble had been determined, practical remedies were found in the application of magnesium limestone, basic slag, and manganese sulphate, materials that are easily secured by farmers at moderate prices. Lack of these minor constituents in the soil threatening to frustrate an attempt to grow narcissus bulbs in South Carolina was corrected by the station, as explained on page 31. (See also pp. 40, 50.)

Simple tests for soil fertility.—Many simple and rapid methods whereby practically every kind of soil deficiency may be determined with a reasonable degree of accuracy have been developed by the experiment stations.

The so-called "plaque method", a bacteriological test developed especially by the Colorado station and found useful for the quick determination of the fertilizer needs of Colorado soils has been further studied with a view to adapting it to different soil types and conditions by the Colorado, Connecticut, Iowa, Massachusetts, and Wisconsin stations among others.

During recent years much interest has centered around the use of the plant itself as an indicator of nutrient deficiencies. Symptoms displayed by the growing plants have long been considered one of the most reliable aids in recognizing potash deficiencies. The Indiana station has recently published a simple and rapid test for potash needs of plants based upon extraction of soluble potash from the plant material, its precipitation as cobalt nitrate under definitely specified conditions, and comparison with prepared standards or color charts. Tests of the method on corn, potatoes, and soybeans gave good correlation with fertilizer treatments and yield responses. A practical system of diagnosis of soil needs and plant-nutrient requirements is furnished by a series of simple chemical tests and color reactions perfected and published by the Michigan station.

FIELD CROPS

Investigations relating to field crops cover a wide range and constitute a major feature of the work of the stations. They have as their primary objective more economical production, improvement of quality, and better use of the products. The diversity of this work is here indicated by a relatively few examples recently reported.

Improving the quality and market value of cotton.—The stations in the cotton-growing sections, cooperating with the Department of Agriculture, have been very active in study of ways and means of improving the quality and price of cotton. The experiment stations in Georgia, South Carolina, and other Southeastern States have shown that until recently these States have failed to produce the quality of cotton demanded by the mills. The need for improvement in this respect is indicated by the fact brought out by the Georgia station that approximately 82 percent of the cotton produced in Geor-

gia has a staple length of seven eighths of an inch or less, but that few farmers receive adequate premiums for cotton longer than seven eighths of an inch or discounts on cotton less than seven eighths of an inch. The result is that cotton growers have not generally been interested in improving the quality of cotton they raise. Variety tests by the station in different parts of the State have shown that several good yielding varieties of cotton with a staple of from 1 to $1\frac{1}{16}$ inches are available. The station has endeavored to develop an interest in production of improved cotton staple by starting one-variety communities in different parts of the State, and has distributed directly for this purpose about 2,000 bushels of seed, and indirectly about 12,000 bushels. Farmers who produce better staple are beginning to receive a premium of from 65 to 100 points. Mill tests of the cotton showed it to be equal to western cotton of the same growth.

A cotton survey by the South Carolina station in 1928 showed that the mill requirement is largely for cotton fiber ranging from $\frac{15}{16}$ to $1\frac{1}{16}$ inches in length, but that the mills at that time were able to secure only about one fourth of their needs in the State. Through variety tests, fiber studies, and spinning tests, the station was able to show that cotton of the desired quality could be produced in any part of the State at no greater cost than the short-stapled poorer quality of cotton commonly grown. As a result of recommendations based on these findings, production of cotton of the staple lengths desired increased from 38 percent of the total crop in 1928 to 75 percent of the crop grown in 1932, representing even at present prices an increased income to farmers of the State of more than $600,000 annually. Furthermore, the mills are now securing practically all of the cotton of the quality desired in the adjacent territory.

An intensive study of cotton culture by the South Carolina station, in cooperation with the Department of Agriculture, in four communities in widely separated parts of the State showed that fields planted with pedigreed seed of improved varieties not only produced better staple but a greater yield of lint cotton per acre, thus pointing the way to more economical production of cotton of much higher quality.

A study of the relation of quality of cotton to local cotton markets and mill requirements in North Carolina has recently been reported by the North Carolina station. This report indicates trends in demand for different types of cotton and suggests changes in production and handling to meet local needs. Marked increases in local consumption of North Carolina cotton have evidently resulted from the cotton-improvement program promoted by the station.

Prices paid to cotton growers in Mississippi, the Mississippi station finds, do not accurately reflect differences in the spinning value of the various grades and staple lengths produced. This is attributed by the station to lack of knowledge on the part of the grower of the correct classification and commercial value of cotton, variations in the character of cotton, inadequate volume of some grades and staple lengths, and differences in bargaining power.

> The failure of farmers to receive prices which reflect accurately the differences in spinning value of cotton of different grades and staple lengths makes it impossible for growers who can produce the higher grades and longer staples to realize the full benefits of their favorable positions. It results in the production of larger proportions of the lower grades and shorter staples than would be the case if production were better adjusted to mill requirements. As a result, net returns to growers, as a group, are reduced, and costs to consumers are increased. * * *
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> The present marketing practices can be improved (1) by having disinterested, competent, and reliable persons classify the cotton according to a uniform standard and issue a certificate showing the grade, staple length, and character of each bale before it is sold by the growers; (2) by encouraging the production of cotton of more uniform quality in each community so that the volume of cotton of each grade and staple length produced in each community will be large enough to be handled more economically; and (3) by supplying farmers with more adequate information on cotton prices in central markets and in nearby points of concentration, including prices for Middling $\frac{7}{8}$-inch cotton and premiums and discounts for the various other grades and staple lengths.

The development of cotton growing in the Southwest has raised many new questions for study by the experiment stations of that region. Experiments by the New Mexico station have been the cause of establishing a one-variety cotton growing industry in New Mexico. It has been estimated that in 1932, 90 percent of the crop was of the Acala variety, on which this station has for a number of years been working, in cooperation with the Department of Agriculture, during which time the staple has been improved considerably. Approximately 100,000 bales of cotton are produced annually

in New Mexico and probably 90,000 or more of these are of this variety, which seems to be peculiarly adapted to the climatic and soil conditions of the Southwest.

Improving corn culture and use.—Some examples of recent progress in station work with corn are as follows:

A hybrid corn which stands up well where other varieties blow down has been developed by the Indiana station cooperating with a practical corn grower. It has a strong root system, is of medium height, and bears ears low on the stalks. It gives a high yield of corn of extra good quality. It has been tested with good results in almost all parts of Indiana, but does best on the rich soils of the central part of the State.

A superior double-cross corn developed and distributed by the Minnesota station is proving popular with farmers, and its culture is being extended in the State. Tests by the station indicate an increased yield of 13 percent with a gain of 10 days in earliness of maturity as compared with varieties commonly grown. Either one of these advantages applied to the 4,500,000 acres of corn grown in Minnesota would greatly increase the returns from the crop. The early-maturing qualities of the double-cross corn are even more important than the increase in yield, in view of the relatively short growing season of the State.

From an investigation of the value for silage purposes of different types and varieties of corn conducted over a period of 6 successive years, the Illinois station concludes that grain varieties of corn, such as Reid Yellow Dent, Leaming, Democrat, and Illinois Two-Ear, are better for silage than late-maturing varieties such as Ardelt, Mexican June, Virginia Horsetooth, Cocke Prolific, and Garrick Prolific. Reid Yellow Dent, on the whole, gave best results in digestible nutrients. Study of the quality of silage produced from corn ensiled under a wide range of moisture conditions indicated that when both keeping quality and palatability are considered, the best results will be obtained by ensiling the corn when it has reached a dry-matter content of about 30 percent.

Improving culture of wheat and other small grains.—Cereal production in California has been profoundly influenced by the work of the California station in cooperation with the Department of Agriculture. Original strains and selections made at Davis were tested throughout the State to determine their adaptability to soil, climate, resistance to disease, and commercial value. Milling, malting, baking, and feeding tests were also made. On the basis of information thus obtained, the variety to plant under a given set of conditions can now be determined with a reasonable degree of assurance that it will grow and yield a product that will command a relatively good price. This work has been of great value to the agriculture of the State, particularly because of its wide variation in soil and climate.

It is estimated that the cereal-improvement work of the Washington station, cooperating with the Department of Agriculture, has resulted in the annual production of 15,000,000 bushels of high-yielding, smut-resistant wheats from station-produced varieties. Through the work of distribution of superior varieties, 600 bushels of pure seed were sent out in 1932 to 41 different communities. The increase from this foundation stock tends to standardize and purify the market grain of the entire State. At the same time new hybrids and selections are being produced and tested so that better varieties than those now in use may be available. The higher yield and reduction of loss from stinking smut through the use of superior varieties has increased efficiency and reduced the bushel cost of production.

A variety of winter wheat, Cheyenne, which appears to be one of the most promising of those tested by the Nebraska station, has recently been distributed to growers by the station.

Selected from Crimean (C.I. 1435), it has surpassed the original by 14 percent in a 5-year field-plat test, while in a preceding 5-year nursery test it proved 21 percent better. During the last 5 years, Cheyenne proved superior in yield to the 65 other varieties tested by the station. In addition to high yield it is characterized by strength of straw, shatter resistance, and Hessian fly tolerance, and is satisfactory in cold endurance and milling characteristics.

Ceres, a high-yielding, rust-resistant, and drought-resistant variety of hard red spring wheat, developed at the North Dakota station and first distributed to the wheat growers in 1926, is estimated to have been grown on about 4,000,000 acres in the United States and 1,000,000 acres in Canada in 1933. Because of its resistance to stem rust, it has replaced a large percentage of the poor quality

red durum wheat formerly grown, resulting thereby in a marked improvement in the average quality of spring wheat. Its drought resistance has made it of material value in the drier regions in reducing losses from dry weather and thereby reducing costs of production.

A single plant of Fulcaster wheat that was superior to all the other plants in the field in vigor and in tillering was found by the Pennsylvania station in 1909. The head was harvested separately and used in breeding for high yield and trueness to type. In 1918 this strain of Fulcaster was distributed to the farmers of Pennsylvania under the name "Pennsylvania 44", or Nittany. It usually outyielded the best existing varieties 3 to 5 bushels an acre in most parts of the State. By 1925 over 360,000 acres of Nittany were grown in Pennsylvania, which is over one third of the total acreage. It is estimated that in 10 years this variety added $10,000,000 to the wealth of Pennsylvania.

Progress in breeding varieties of wheat resistant to stinking smut and of oats to both loose and covered smut is reported by the Pennsylvania station. High-yielding resistant strains of both grains have been developed, and the best of these selections which have shown no smut through three generations, although fully exposed to infection, are being distributed to grain growers. The economic importance of such work is shown by the fact that in 1931 stinking smut caused a loss of about 17 percent of the wheat crop and 10 percent of the oat crop, and in some years has caused more serious losses. The South Dakota station reports progress in breeding varieties of small grains—wheat, oats, and barley—resistant to such diseases as rust and smut, as well as to drought. Several of the strains thus obtained have demonstrated their value in practice.

In wheat-storage investigations carried on by the Kansas station, it has been shown that by the proper ventilation of the storage bins, wheat containing from 15 to 16 percent of moisture, which would heat and mold in ordinary bins, may be stored safely without fear of damage and marketed in good condition. This damp wheat may be dried and cooled by forcing air through the grain. The rate of movement of air forced through the grain can be varied to suit the requirement because the rate of drying depends upon the rapidity of ventilation. A slow rate of movement of air was found to be all that is needed to keep grain from heating. An air movement equivalent to from 6 to 10 air changes per hour has proved to be effective. Since the cooling effect of ventilation is equally as important as the drying effect, night air has proved to be more valuable than day air. A small power unit, such as a 1-horsepower motor or a 2-horsepower gasoline engine, proved to be capable of moving enough air to ventilate successfully a bin containing several thousand bushels.

An improved variety of oats, the Patterson, bred by the Pennsylvania station, is now grown on 350,000 of the 944,000 acres of oats sown in Pennsylvania annually. The Patterson usually outyields other varieties 5 to 7 bushels an acre. It is estimated that this variety has added $1,000,000 a year to the wealth of the State.

A variety of winter barley with barbless awns which yields well and is of good quality has been produced by the Maryland station through breeding and selection. The variety is proving to be of much value to Maryland farmers, particularly dairymen and livestock men.

The value of barley for feed and the standard requirements for a malting barley have been studied by the North Dakota station, which has found Trebi to be the variety best suited to North Dakota conditions as regards yield. The station finds that North Dakota grown barley is not usually so well suited to malting as barley grown in more humid sections. "This type of barley is most likely to be produced in North Dakota in seasons of higher than normal rainfall, and when temperatures, especially during the ripening period, are favorable for the development of a large plump berry."

Cooperating with maltsters, the Wisconsin station has succeeded in finding varieties of barley especially suited to malting purposes. A variety developed by the station, Wisconsin Pedigree No. 38, has been found to be of superior malting quality—in fact, the equivalent in malting quality to any barley being commercially grown in the United States. This new strain of barley has the additional advantages of being virtually immune to stripe disease, and it likewise outyields other barleys grown in this area from 3 to 10 bushels to the acre. The barley trade had need for large quantities of high-quality malting barley, and the station has been able to assist in the

formulation of regulations governing the grading of barley offered on the market. They have also aided the commercial barley interests in selecting farming areas and soil types which are particularly adapted to the growing of barley with high malting quality. The result of this program, which has been cooperative between commercial barley industries and the station, has been the creation of a market for tremendous quantities of high-quality barley which the farmers have been able to sell at a price from 5 to 25 cents per bushel greater than the price of barley on the open market.

A variety of rye received by the Tennessee station from Italy about 14 years ago, to which the name Balbo has recently been given, has proved to be especially suited to Tennessee conditions. Balbo rye is characterized by a rapid upright growth and high yields. The upright habit and rapid growth makes the variety of outstanding value for pasturage.

The prediction of the Hessian fly-free date each fall, so as to avoid heavy fly infestation in winter wheat, represents a very practical phase of the work of the Iowa station. Knowing the probable date, it is possible for the farmers to begin sowing wheat about 1 week before the end of the egg-laying period of the Hessian fly. This work has saved millions of bushels of wheat for the Iowa farmers during the past 10 years. In many counties from 90 to 100 percent of the farmers cooperate with the station in this work.

A simple and dependable method of determining hardiness of crops is much needed. Promising methods of artificial freezing have been devised and are being tested by a number of stations cooperating with the Department of Agriculture. In tests with more than 120,000 plants of winter wheat, rye, oats, and barley, the Kansas station found that—

> without exception the injury by artificial freezing of regional varieties of winter wheat, other than those included in the winter-hardiness nurseries, was in agreement with their relative hardiness under field conditions in the Great Plains, so far as information regarding the latter is available. It is also in agreement with the supposition that the distribution of varieties in other portions of the United States is often limited by their inability to survive low temperatures.

Similar results were obtained with winter barley, oats, and rye, confirming the presumption that resistance to cold is a dominating factor in determining adaptation and distribution. Artificial refrigeration was used with apparent success to eliminate nonhardy varieties in mixtures and nonhardy segregates in hybrid populations of a number of crosses. Among other stations engaged in investigations of this kind are those of Illinois, Minnesota, and Nebraska.

Potato culture.—The need for diversification in the potato-growing section of Maine is becoming more evident from year to year. Recognizing this need, the Maine station is attempting to determine other crops that may be profitably used for this purpose. It has been found that peas for canning do well and give high yields. One advantage of peas is that the vines and pods may be returned to the land and thus help to maintain its fertility. It appears that peas for canning can be produced very cheaply and have the advantage of being a cash crop. Flax has also been tried with encouraging results.

Experiments in potato growing by the Louisiana station, in cooperation with the Cuba Agricultural Experiment Station, have demonstrated the superiority of Louisiana certified seed over Canadian seed, which has been used in the island. As a result of this investigation, 14 cars of Louisiana-grown seed worth $10,000 were sold for use in Cuba in 1933, thus developing a good market for the smaller potatoes which in seasons of low prices are a drug on the market.

Investigating the question of the relative quality of seed potatoes grown with and without irrigation, the Montana station reached the conclusion that as good seed potatoes can be produced under irrigation as without it. This is a matter of considerable importance because of a prejudice on the part of some growers against irrigated seed potatoes.

The yield and quality of potatoes, the Montana station finds, are improved by use of phosphates on most of the soils of the State. Phosphated plats yielded approximately 3,000 pounds more of no. 1 grade potatoes than unfertilized plats. The use of phosphate not only resulted in higher yields and better quality, but had the additional advantage of hastening maturity, thus eliminating some of the hazards of fall freezing.

The most effective methods of placement of fertilizers for various crops has been studied by a number of experiment stations cooperating with the Department of Agriculture. The New Jersey station reports that as a re-

sult of experiments on placement of fertilizers for potatoes, there has been a decided change in methods of applying fertilizers in the central New Jersey potato belt. Growers are giving more attention to the matter than ever before, with the result that stands and yields are being much improved without extra cost.

That control of psyllid yellows of the potato is possible where the carrier insects can be eradicated appears to have been established by further investigations reported by the Utah station, cooperating with the Department of Agriculture. The importance of this discovery is evident when it is realized that this disease is a perennial menace (even to the extent of elimination) to potato growing in Utah and Colorado and is also a cause of serious loss in tomato growing.

Potato-marketing studies by the Maine station indicate the advantage of marketing only the highest grades, thus building up a reputation for quality and meeting the competition for top prices with potatoes grown in other regions. The station suggests that a quality product can usually be sold advantageously when potatoes of mediocre or poor quality fail to find a market, and that Aroostook potatoes would move to the market more rapidly if sold as Fancies and U.S. No. 2's. A recent study of the marketing of potatoes showed that grading of the product into two classes, Fancy Brushed and U.S. No. 2, was effective in gaining a net return of from $10 to $20 more per car than could be obtained for U.S. No. 1 alone. The economic importance of this finding is indicated by the fact that Maine ships 40,000 to 50,000 cars of potatoes annually.

Price control of potatoes through an agency of growers which also will have authority to stop or start harvesting the crop as the demand may justify has been in process of establishment during the past year by the New Jersey station in cooperation with growers.

An efficient method of pit storage of potatoes has been devised and published by the West Virginia station.

Improving tobacco culture.—From a long-continued study of tobacco-cropping systems, the Massachusetts station concludes that tobacco is at its best on well-drained alluvial soils under a continuous-cropping system. Manure as a supplement to fertilizers applied to tobacco in continuous culture was found to be beneficial as regards quality.

Tobacco is known as a "potash feeder." Two forms of potash are in common use in fertilizers for this crop, namely, sulphate and muriate (chloride) of potash. There is a common belief that fertilizers, such as muriate of potash, containing chlorine, lower the quality of tobacco, but the Kentucky station finds after years of experiment with sulphate and muriate of potash on white burley tobacco that there were no injurious effects from use of the muriate of potash, supplying 25 pounds of chlorine per acre, and no reason to expect injury from twice that amount.

Improving sugar production.—When sugar production, the leading agricultural industry in Puerto Rico, was threatened some years ago by the rapid and devastating spread of mosaic disease in the cane fields, the Puerto Rico Experiment Station at Mayaguez cooperated with the Department of Agriculture in distributing an immune variety of cane which checked the spread of the disease and literally saved the industry. More recently the station, as well as the Department of Agriculture, has been active in developing and introducing varieties of sugarcane of superior quality and resistant to mosaic, such as P.O.J. 2878, which is now one of the leading varieties grown in Puerto Rico. Mayaguez 28, a promising seedling variety developed by the station, now occupies about 5,000 acres in the island. The station is making most encouraging progress in breeding not only for high production but for resistance to disease, and no single factor is doing more for the sugar industry of the island than such improvement of varieties.

Borer-infested sugarcane has been found by the Louisiana station to be inferior to uninfested cane for planting. Its use results in poor stands and reduction of maturing stalks and yield, the reduction in yield being as high as 7 tons per acre in heavily infested seed cane. The station therefore recommends that every reasonable effort be made to secure cane as free as possible from borer attack.

Development of sugar-beet seed production.—The overwintering-in-the-field method of sugar-beet seed production developed by the New Mexico station cooperating with the Department of Agriculture has passed the experimental stage and is coming into commer-

cial use on a considerable scale in the southern Rio Grande Valley in New Mexico. This method has the advantage over the conventional method of seed production that, in the mild winter climate of the Southwest, beets will grow over winter from plantings made in September and produce seed the following year, thus greatly shortening, simplifying, and cheapening the operation of seed production. More than 400,000 pounds of high-quality seed, chiefly of the curly-top-resistant variety (U.S. No. 1) recently released by the Department, was produced in New Mexico by the new method in 1933, with the expectation that more than 1,000,000 pounds would be so produced in 1934. Heretofore the United States has been largely dependent upon imported seed, nearly 20,000,000 pounds of which is required annually by the sugar-beet growers of the country. In view of the progress that is being made with the new method, there appears to be good reason to expect that this country may eventually become, in large measure, independent of the European seed supply.

Flax growing.—The results of seed flax-variety studies, by the Maine station, in Aroostook County indicate this crop to be the equal of oats as a cash crop. Tractors are being used for many farm operations, thus reducing the number of horses and lessening the demand for oats as feed. Since this country does not produce enough flaxseed to supply the domestic demand, an increase in this crop as a substitute for oats would be a good thing. The seed flax-growing industry of South Dakota has been materially aided by the work of the station, showing optimum dates of seeding. Practical application of the discovery by the station that flaxseed yields can be increased greatly by seeding at the optimum date in April, it is estimated, has increased the yield by 2 or 3 bushels per acre in the seed flax area. One of the most serious difficulties encountered in seed flax growing has been losses due to wilt, rust, and other diseases. Several of the stations, including particularly those of Minnesota and North Dakota, have developed disease-resistant strains of seed flax which have in large measure overcome this difficulty.

Dusting peanuts with gypsum.—Dusting peanuts with gypsum is an old and popular practice, the value of which has been uncertain. The North Carolina station has found that dusting gypsum on leaves of large-type peanuts at blooming time is of value if the soil has not been limed. It has not proved profitable on Spanish peanuts.

Harvesting grain sorghums.—There has been a considerable demand for a grain sorghum which can be harvested with wheat machinery. The Kansas station, in cooperation with the Department of Agriculture, has succeeded in developing such a sorghum, known as Wheatland. This sorghum appears to meet the required conditions and to be especially suited to conditions in all sections of Kansas except the northwestern counties, where it may not mature because of the short season.

Soybeans.—Soybeans have been adapted to Delaware conditions by selection, variety testing, inoculation, and fertilizer investigations of the Delaware station. The importance of such work is indicated by the fact that the seed crop alone has been worth more than $3,000,000 to Delaware farmers in the last 10 years.

Soybeans have become a major crop in various parts of the country. A recent bulletin of the Illinois station says:

> Soybeans, important for centuries in certain oriental countries, have recently claimed a position in the national economy of the United States well beyond that which might have been expected even a few years ago by persons not fully familiar with the wide range of uses of this crop and its adaptation to the soils, climates, and farming systems of this country.

The station has recently reported an exhaustive study of present production, potential markets, possible improvements in marketing, and various features which affect the price of soybeans and soybean products. The present production of soybeans in the United States is stated to be between one third and one half million tons annually, nearly 9 percent of which is produced in the East North Central States and 7 percent in the South Atlantic and East South Central States. Production and use of the beans for feed, oil, and other purposes are shown to be increasing.

> In a surprisingly brief period soybeans have become the object of widespread attention among dealers and among leaders in numerous industries. The extent to which soybean oil can be used to advantage is being determined more and more accurately by research specialists in establishments producing paint, soap, and edible products.

(See also p. 44.)

FORAGE CROPS

Improvements in alfalfa culture.—Low resistance to cold and to wilt have been shown by the Nebraska station cooperating with the Department of Agriculture to be the major causes of failure of alfalfa in Nebraska. The station found that in comparative tests of alfalfa grown from seed obtained from many different sources only those of Turkistan origin showed any considerable degree of resistance to wilt. The station reports encouraging progress in its efforts to secure strains of alfalfa resistant both to cold and to wilt. Hardistan, a variety discovered and named by the station, has shown unusual qualities of resistance to wilt and cold. A method has been developed by which hardiness in alfalfas can be determined by their enzymatic response.

Many years' study of the relation of subsoil moisture to alfalfa production under widely varying conditions, by the Nebraska station and the Department, has led to the conclusion that the yields of alfalfa are determined not only by the current rainfall but by the moisture in the subsoil to depths as great as 35 feet. The continuous growing of alfalfa tends to reduce the subsoil moisture to such an extent that the crop is wholly dependent on rainfall. The restoration of the subsoil moisture following its exhaustion by alfalfa is extremely slow. Conditions which favor this are level topography, open soil texture, high rainfall, low evaporation, and weed control. Five years of continuous summer-fallow completely restored the subsoil moisture in alfalfa sod land to a depth of only 12 feet and it is estimated that it would require 10 years of such fallow to replace all the water initially removed by the alfalfa during the previous 5-year period.

The conclusion is that summer-fallowing for reestablishment of alfalfa, aside from its value in securing a stand, is not a profitable practice. Although the phenomenal yields frequently obtained during the first few years of an initial cropping to alfalfa are not likely to be again possible for many years, alfalfa may still be grown as a reasonably profitable crop.

Kaw, an alfalfa strain originating in Turkistan and studied by the Kansas and Nebraska stations, cooperating with the Department of Agriculture, appears to have qualities of unusual value. Norwis, an alfalfa similar in type to Grimm, that has shown unusual resistance to winter injury and also is a liberal producer of seed, has been developed by the Wisconsin station.

With the growing interest in artificial methods of curing hay, many of the experiment stations have made comparative studies of the effect of artificial and natural curing of hay on the quality and nutritive value of the product, particularly as determined by the vitamin content. The Arizona station has found that sunshine increases vitamin D and decreases vitamin A in alfalfa hay. The Nebraska station found artificially cured alfalfa to be twice as potent in vitamin A as field-cured, and that artificial curing tended to preserve vitamin E. The Wisconsin station finds that rapid dehydration of freshly cut alfalfa tends to preserve the minerals, proteins, and especially the vitamins in the alfalfa. (See also p. 37.)

The vitamin A content of alfalfa hay decreased as the length of the period of exposure to sunlight increased, in experiments reported by the Arizona station. Alfalfa allowed to lie in the swath for 24 hours after cutting had lost 84 percent of its vitamin A content as compared with a sample cured in a darkened house. In contrast to the above, the vitamin D content of alfalfa hay increased as the exposure to sunlight increased. Alfalfa hay that had been cured in the dark failed to alleviate induced rickets in experimental rats. On the other hand, hay that had received 57.3 hours of sunshine was highly antirachitic. Such long exposures are not, however, to be recommended.

Sweetclover.—The Kansas station states that farmers have been discouraged from growing sweetclover because of the belief that heavy and costly applications of lime were necessary to neutralize soil for this crop. Recent experiments by the station, however, in which lime was applied in the row by means of a fertilizer attachment on a grain drill, have shown that 200 to 300 pounds of finely pulverized limestone give as good results as heavier applications made broadcast. Sweetclover was thus successfully grown by use of about one twentieth as much lime as has been recommended in the past. It is believed that the adoption of this simplified and less expensive method will mean the more general use of sweetclover as a pasture and soil-improve-

ment crop in the humid sections of the country, where soils are so low in lime that sweetclover production is difficult.

Lespedeza sericea.—*Lespedeza sericea*, introduced into this country by the Department of Agriculture, has recently attracted wide attention and exploitation. The Tennessee station finds that—

> as a pasture and hay crop [*Lespedeza sericea*] will probably last 10 or more years and furnish at least two crops of hay a year, either one of which will surpass the average farm hay crop. The seed can be raised in abundance on any farm and harvested with the minimum of effort. *Sericea* is a legume, and therefore would be expected to be a soil improver. Its true value is being studied from various angles by the station. * * * But time will be required to work out the best ways for its utilization and to establish it as a farm crop.

Sudan grass.—Sudan grass continues to receive attention by a number of experiment stations. The Delaware and Michigan stations find it to be a valuable emergency or supplementary pasture grass, especially for summer pasture when droughty conditions are likely to prevail. (See also p. 39.)

Sudan grass has been shown by the Tennessee station to be of outstanding value for summer pasture in the central part of the State, not only withstanding hot and dry weather remarkably well, but producing a highly nutritious forage comparing favorably for milk production with the best legumes.

An increase in the acreage devoted to Sudan-grass pastures has followed experiments by the Texas station which show that Sudan-grass pasture is a cheap and excellent feed for growing swine and steers. In the steer-feeding experiment, it was shown that steers on Sudan grass alone gained as rapidly as those on Sudan grass with a supplement of cottonseed meal. Hogs pastured on Sudan grass gained rapidly, and on a basis of grain and protein supplement saved by the pasture the Sudan grass was found to be worth $16.29 per acre. Approximately a million acres were planted to Sudan-grass pasture in Texas in 1933, the crop in many instances replacing land previously in cotton.

An improved variety of timothy.—Huron, a variety of timothy developed by the Ohio station in cooperation with the Department of Agriculture, appears to be especially suited to the Pacific Northwest for production of hay and for farm and range pastures. However, it is not recommended for parts of the Central West where timothy seed is produced extensively for general distribution.

Improvement of pastures and ranges.—The introduction and establishment of improved pasture grasses, which have been carried on for many years by the Florida station in cooperation with the Department of Agriculture, have now reached a point where definite results are available. Through the use of such grasses Florida cattlemen have been enabled to increase the carrying capacity of their pastures from twofold to tenfold over the native grasslands. In conjunction with improved pastures, the station has assumed a leading part in the breeding up of the native range cattle, and the results of this work are now becoming visible throughout the cattle-growing areas.

As a result of cooperative investigations between the Hawaii station, the Department, and ranchmen of Hawaii, nearly all of the more progressive ranchmen of the islands have introduced new species of grasses on their ranges.

> Many improved American and European grasses are now established on the higher levels, where soil and climatic conditions more nearly approach those of the Temperate Zone than do the conditions elsewhere in Hawaii; and introductions from Africa, Australia, and India have greatly improved the grass ranges of the lower levels, particularly in the drier regions.

In its experiments on methods of maintaining and restoring the productivity of native pastures, the Kansas station has found that deferring grazing until about June 15 every alternate year has resulted in 35 percent increase in grazing capacity over pastures grazed season-long. Grazing at this stage of growth makes it possible to utilize the grass when it is palatable and nutritious and yet have sufficient storage of food reserves to withstand rather close cropping. Livestock grazed on the deferred pastures made an average gain of 1.95 pounds per day and a total seasonal gain of 83 pounds per acre. On the pastures grazed season-long the average gain was 1.7 pounds per day with a total seasonal gain of 54 pounds per acre.

Nitrogen-fertilized pastures under rotation management were found by the New Jersey station to afford abundant forage 2 weeks earlier than those fertilized without nitrogen. The nitrogen-fertilized pastures also furnished 1 month more grazing. It is estimated that the net return from nitrogen fertilization plus rotation pas-

ture management was in this case equivalent to $48 per acre when compared with barn feeding.

From a study of the adaptability to Wisconsin dairy farms of an intensive system of pasture management, the Wisconsin station concludes that dairy farmers of that State could with profit adopt in whole or in part some form of pasture management involving systematic rotational grazing and fertilizing.

See also p. 12.

Injurious effect of close clipping of lawns.—From a study of the effects of different rates of clipping lawns and other grasses, the New Jersey station concludes that undoubtedly many lawns and similar areas are injured by the common practice of close mowing, which restricts root growth and increases summer drought injury.

COFFEE

Coffee culture in Puerto Rico.—When the coffee plantations in Puerto Rico were devastated a few years ago by a hurricane, the station, as a result of its previous work on coffee, was prepared to distribute in quantity seeds of a superior strain, Excelsa, and to give timely advice regarding improved methods of culture and fertilizing which had a large part in rehabilitating coffee culture in the island. The station has shown the value of fertilizers, particularly potash fertilizers, and of shade in improving the coffee crop, which has been deteriorating in yield and quality for some years.

FRUITS, FLOWERS, AND VEGETABLES

Present economic conditions make it imperative for the horticulturist, as well as the general farmer, to reduce the cost of production to the lowest point consistent with a satisfactory yield and good quality of product. Work of the experiment stations, having as its object the improvement of horticultural methods and products, is of wide range and variety and the results are finding many profitable applications in practice. The following are a few of the many examples of recent work of the stations which might be cited in support of this statement.

New and improved varieties.—The origination and introduction by the stations of superior varieties and strains of horticultural plants is going forward with unabated vigor and with increasing benefit to horticultural practice.

Among the recent additions to new and noteworthy fruits developed and introduced by the New York (State) station, which has been an outstanding leader in such work, are the Kendall apple, Ovid and Willow pears, Early Rivers and Emperor Francis cherries, Oriole (p. 29) and Valiant peaches, Naples raspberry, and Cato, Clermont, and Culver strawberries. This station has to its credit many improved varieties which have to a large extent replaced less desirable and less profitable varieties previously grown. Many other stations have made valuable contributions of the same kind.

Apples and pears.—Experiments conducted by the Pennsylvania station since 1920 have indicated that apple growers may secure better yields by keeping the orchard in a temporary legume sod or by sowing annual cover crops in May than by sowing in July as has been done. In this way the supply of organic matter in the soil is maintained, instead of being burnt out by frequent summer cultivation. These results now are applied on over 50,000 acres of Pennsylvania orchards, at an estimated saving of $1 to $3 an acre per year, or about $100,000 annually.

From fertilizer experiments with apples extending over many years, the New York (State) station finds that this fruit, as a rule, responds profitably to nitrogenous fertilizers, especially the more readily available forms of nitrogen, such as nitrates and ammonium sulphate, if such fertilizers are not used in excessive amounts. Excessive applications of nitrogen have been shown to increase yield at expense of color. Similar results have been obtained by the New Jersey station.

Cause and prevention of culls in apples has been studied extensively by the Missouri station, the studies involving examination of over 100,000 culls. The causes of culls, as rated in descending order of importance by the station, were lack of size, mechanical injury, lack of color, and disease and insect injuries.

Notwithstanding the great amount of investigation by the experiment stations and the Department of Agriculture, the codling moth remains an outstanding hazard in the culture of apples and other fruits. In view of the apparently increasing difficulty of controlling the codling moth with common sprays, and the need for avoiding spray residues containing arsenic and lead, station effort is being directed toward finding other means of control,

such as new insecticides, chemically treated bands, orchard sanitation, and mon sprays, and the need for avoiding also p. 36.)

An efficient means of controlling the apple curculio, which is one of the serious hazards in apple culture, has been found by the Kansas station. The station observed that the curculio overwinters as an adult in dead vegetation from one eighth to one fourth of an inch above the soil directly under the trees, and suddenly appears at blooming time, causing damage to twigs and newly set fruit. Burning of the dry orchard cover during the winter months with covered pressure burners destroyed the beetles in hibernation, with little or no injury to the trees or bluegrass sod in the orchards. The cost of the burning was about $10 per acre.

The plum curculio frequently causes heavy losses to apple growers. The Massachusetts station undertook to determine the factors which influence the activities of the insect as a basis for developing effective methods of control. Early in the work temperature was found to play an important part in the problem of control, and it is now known that sprays applied during periods of low temperatures when insects are comparatively inactive give these pests an opportunity to develop a pronounced degree of tolerance before they consume the amount of poison that would ordinarily prove fatal. These findings not only have a significant bearing on the economic effectiveness of spraying for insect control, but explain many apparent inconsistencies in control methods.

In a study of apple storage, the New Hampshire station obtained evidence that subjecting certain varieties of apples to low temperatures (40° F.) immediately after picking is not good storage practice. Similar results have been obtained by other stations.

Fire blight, one of the most destructive diseases of apples and pears, has been the subject of investigation for many years by the experiment stations and the Department of Agriculture. The Arkansas station has recently announced that in Arkansas the disease may be controlled largely by spraying with weak bordeaux mixture during the blossoming period without spray injury. This appears to offer a more practical and efficient program for the control of this disease than has heretofore been available, and apparently provides a simple solution for what has hitherto been a baffling problem. A spray found to be effective is a mixture of 1 pound of copper sulphate and 3 pounds of hydrated lime in 50 gallons of water applied when the blossoms open.

From experiments on fire-blight control in a commercial orchard, the New York (Cornell) station found that fair to good results were obtained by standard methods of orchard management "at an average annual cost scarcely greater than that of a single spray application in the same orchard." It is stated, however, that these methods are "tedious and difficult, resulting so frequently in failure that competent men have been led to question their efficacy." The usual methods followed involve the use of resistant stock, removal or treatment of infected parts, and maintenance of tree vigor by use of fertilizers.

A number of fundamental principles regarding the effect of temperature upon nutrition and growth of different varieties of apples have resulted from investigations by the New Jersey station in cooperation with the University of Chicago. For example, it was learned that the Baldwin apple assimilates nitrogen at a lower temperature than Stayman Winesap, but Baldwin respires carbohydrates more rapidly at 95° F. than Stayman Winesap. These fundamental facts have a direct and practical bearing upon the matter of adaptability of varieties to different climatic conditions and zones.

Comparative tests of different varieties of apples for cider making have been reported by the Ohio station. These have shown Delicious, Grimes Golden, Baldwin, Golden Delicious, King David, Jonathan, and Ben Davis to be well suited for the purpose. The station recommends that only good sound apples be used for cider making and suggests that the product can be improved by blending varieties in different ways.

A method of clarifying fruit juices recommended by the New York (State) station has been widely adopted in the clarification of apple juice and is proving to be a practical and economical means of improving this important byproduct of the fruit industry. Apple juice is now being clarified and carbonated by a method developed by the station, and this clarified and carbonated juice is being marketed in bottles in much the same way that ginger ale and other carbonated drinks are handled. The new beverage is proving exceedingly popular and seems to have opened up a

new outlet for fruit juices. The method involves the coagulation of the suspended colloidal material in the juice by heating to 180° F. for 20 seconds, cooling immediately, and then passing the juice through a germ-proofing filter which gives a sparkling clear juice that is sterile and can be filled into sterile containers for the market.

An apple concentrate.—An apple concentrate has been developed by the Washington station which contains a comparatively small quantity of moisture and has a sugar content sufficiently large apparently to make it keep indefinitely. It may be used for a number of purposes, particularly for apple pie or apple sauce, and perhaps as a confection. Packed in cellophane or similar packing material, it has an attractive appearance, and since the moisture content is low the cost of transportation is small. Only limited space is required for storage. It is believed that large quantities of the lower grades of fruit may be converted into this concentrate and marketed throughout the year, thus providing additional revenue to the fruit grower.

Cherries.—From studies of pollination of cherries, the New York (State) station found Early Richmond, Montmorency, and English Morello, sour cherries, to be self-fruitful; all sweet cherries proved to be self-unfruitful. The Duke type intermediate between sour and sweet cherries, was found to be self-fertile and a good pollinizer of sweet and sour cherries. The results have an important bearing on fruitfulness in cherry orchards.

Citrus fruits.—Studying the relation of temperature to the effect of irrigation on citrus trees, the Arizona station found the slow growth of young trees on the Yuma Mesa in southwestern Arizona and their slowness in coming into profitable bearing to be due to excessive soil temperatures, as high as 93° F., which checked growth and prevented the normally lush summer growth. It was found that without soil-temperature control, the temperature in the root zone exceeds 100° for a part of the day for nearly 3 months beginning about June 20. Control appears to be entirely feasible and at moderate cost, by several methods, as follows: (1) By frequent light irrigations; (2) by heavy straw mulch; and (3) by a green cover crop, cowpeas apparently being the best for this purpose. As the spread of the trees increases, with increased shade on the ground, the effect of high soil temperature decreases. But even then the root systems reach far out into unshaded ground, and studies of transpiration loss show that for half-grown trees the use of water by the trees is decreased during the hot period.

The effect of different types of wrappers, such as waxed paper, aluminum foil, and cellophane, on the keeping quality of citrus fruit was studied by the Florida station with quite definite results. Aluminum foil and cellophane were clearly and consistently superior to the common tissue and oiled papers in that they tended to repress loss of moisture from the fruit and kept the fruit in a firm, sound condition for long periods. Unwrapped or paper-wrapped fruit under like storage conditions lost weight rapidly and soon shriveled, particularly around the stem end.

A study of citrus freight rates, made by the Florida station some years ago, is believed to have played an important part in bringing about reductions in rates to Florida growers in 1932 and 1933. In 1932 the rate reductions from January through June created a saving of approximately $1,000,000 to the Florida growers. The reduced rates in effect in 1933 did not aggregate so large a total saving, but it was considerable.

Studies of citrus packing-house costs in Florida, made by the Florida station some years ago and supplemented with more recent data, gave results which are playing an important part in reducing the cost of handling citrus fruits. In these studies it was found that the cost per box for picking, hauling, and packing citrus fruit had been reduced from 93 cents in 1924–25 to 76 cents in 1931–32, or 18 percent. The reduction in cost was principally in labor and materials. The reduction in the cost of day labor per box was far greater than for piece labor, such as packing and box making, indicating that much progress had been made since 1924–25 in the arrangement of packing houses as recommended by the station some years ago. The principal improvements noted were that many houses had been rearranged in order that the fruit would move through the packing house from the receiving platform to the car with a minimum of back tracking; secondly, an increase in the installation of conveyor service to carry fruit to the washer, cull fruit to the dump, and empty field boxes from the packing house, thus saving much labor and confusion. A third improvement noted was that fewer

2-story packing houses were being built than formerly. The studies showed that normally the packing costs are higher in the 2-story houses than in the 1-story houses.

Purple scale is one of the most serious pests of citrus fruits in Florida. The Florida station has found that 2 or 3 applications of lime-sulphur spray in the summer months will hold the scale in check and at the same time control both rust mites and red spiders. The addition of 1 pound of iron sulphate to 50 gallons of the spray, as recommended by the Department of Agriculture, increased the efficiency of the material and caused it to stick much longer.

Following previous work on the extraction of orange juice, the Florida station has developed methods of cool storage of the juice in milk bottles for periods of a week or longer. Since the temperature and general procedures do not vary greatly from those used in the handling of milk, it will be possible to deliver orange juice alone, or in conjunction with milk, to large consumers such as restaurants, hotels, or fountains, and if the juice is stored at the same temperatures used for milk it can be kept for a week or more without loss of flavor.

Temporary preservation of fresh figs in sulphur dioxide.—The Texas station has perfected a cheap and effective method of temporarily preserving fresh figs for future domestic and foreign processing by the use of a weak solution of sulphur dioxide, thereby alleviating the seasonal surpluses of this highly perishable commodity, extending the home- and commercial-canning period, and affording a better utilization of both labor and plant facilities.

Peaches.—Varieties of peaches of superior quality especially adapted to New Jersey conditions have been developed by the New Jersey station as a result of many years of such work. These improved strains have been widely distributed to peach growers in the State. From 1921 to 1929 the station developed and distributed more than 30,800 trees of about 15 new varieties. From 1929 to 1933 it distributed about 128,000 trees of a limited number of new selected seedlings. The old standard varieties of peaches, such as Greensboro, Carman, Hiley, and Belle, are no longer profitable in New Jersey, and the same is true for many other peach districts. Even the widely known variety Elberta has not been profitable for New Jersey growers in recent years. If it were not for the fact that the New Jersey station had developed promising new varieties for New Jersey growers they would be greatly discouraged over the prospects of the industry at the present time. During the season of 1932 Golden Jubilee, one of the new varieties, was about the only variety to sell for good prices in southern New Jersey. In tests of 56 varieties of peaches to determine adaptability to freezing in small-consumer packages, the Bureau of Plant Industry of the Department of Agriculture found that 3 of the 9 varieties ranking excellent for the purpose were varieties developed by the New Jersey station, namely, Oriole, Eclipse, and Primrose.

Many native parasites of the oriental fruit moth which appear to give promise of aiding materially in the control of this destructive pest of the peach have been found by different stations. The Michigan station reports that such parasites are becoming increasingly effective and may in time establish a natural balance which will keep the pest in control.

Profitable marketing of peaches depends very largely upon the stage of ripeness at which the fruit is harvested and the condition in which it reaches the market and the consumer. The Utah station concludes from a careful study of the subject that harvesting of peaches should be delayed as long as possible and still have them reach market in good condition. Firmness, as determined by the pressure test, and coloration, indicating the best condition for harvesting for shipment to distant markets, as well as methods of handling, have been worked out in detail by the station.

Plums.—Many superior varieties of plums have been developed and distributed by the experiment stations. The Minnesota station, which has taken a leading part in such work, is responsible for Superior and Red Lake varieties, as well as Burbank × Kaga crosses, which appear to be of superior quality and especially adapted to conditions in the State and in similar sections.

The plum tree borer is reported to be the most important factor except drought limiting the life of plum trees in South Dakota. The station has found that paradichlorobenzene applied to the bark of the trunk and larger limbs of plum trees, either in the form of a paint made by mixing the paradichlorobenzene with paraffin,

or in the form of a liquid made by mixing it with cottonseed oil, is an effective means of protecting trees against this pest. This method opens up possibilities of controlling borers in all kinds of trees and thus effecting large savings.

Small fruits.—The work of the stations with small fruits is extensive and varied.

Development of blueberry growing as a promising new industry in Washington State has been aided by work of the Washington station.

In view of the importance of the cranberry crop in Massachusetts and of the fact that processing and preserving of this fruit is increasing, the Massachusetts station has undertaken to determine the changes which actually occur in this fruit during storage, processing, and preservation. From results so far obtained it appears that handling and manufacturing methods may greatly alter the nutritive value of cranberries and cranberry products. A gradual loss of vitamin C was observed in cold storage. Freezing did not injure the antiscorbutic properties of whole, sliced, crushed, or sweetened cranberries. The temperature of freezing and length of storage had little effect. There was evidence, however, that thawing and subsequent freezing lowered the vitamin C content. Evaporated whole cranberries were found to be deficient in vitamin C. Fresh or boiled cold-pressed cranberry juice with or without added sugar was nearly equal to the fruit in vitamin C content. However, when either cold-pressed or heat-extracted juice was bottled and pasteurized most of the vitamin C was lost. Whole-fruit sweetened cranberry sauce retained a large part of its vitamin C. On the other hand strained sauce usually retained less than 20 percent of this vitamin. Clear cranberry juice made into jelly contained no significant amounts of vitamin C. Dehydrated cranberries contained significant amounts of vitamin A. No significant amounts of vitamins B, D, and G were found in cranberries. (See also p. 53.)

Raspberry growing in New York has declined in recent years. There is a movement to reestablish culture of this small fruit as a profitable industry in the State which the New York (State) station is aiding by supplying information derived from its investigations regarding selection of varieties, correct methods of culture, control of diseases and insect pests, and harvesting and marketing. The need of such assistance, if the industry is to be reestablished, is evident from the fact that from 1899 to 1929 the acreage declined 36 percent and the yield 60 percent, these decreases being due to disease, especially mosaic, and decline in demand for the preserved product. An effort is being made to find mosaic-resistant varieties and to increase the market for the fresh fruit.

Many improved varieties of strawberries originated by the experiment stations and the Department of Agriculture have been distributed and displaced less desirable varieties previously grown. Among varieties of superior merit developed by the North Carolina station, in cooperation with the Department, are Bellmar, adapted to humid conditions, and Southland, resistant to leaf scorch.

An effective system of spraying to control strawberry diseases, particularly leaf spot and scorch, which have been major causes of decline in strawberry growing in Louisiana, has been formulated by the Louisiana station. Spraying with bordeaux mixture seven or eight times during January, February, and early March when conditions are most favorable for the spread of the diseases resulted in almost complete control. This increases the value of the crop from $50 to $200 per acre. These control measures are being practiced at the present time to a large extent by strawberry growers, and have been an influential factor in the survival of the strawberry industry in Louisiana.

Melons.—Methods of controlling downy mildew of cantaloups, one of the most serious menaces to the melon industry, have been studied by the Georgia station, among others, with the result of showing that while bordeaux mixture of the usual concentrations often causes severe injuries to the foliage, very satisfactory results may be obtained with a 1:2:50 bordeaux. The results indicated that under Georgia conditions cantaloup growers may expect an average net profit from spraying of about $10 per acre.

Watermelons have been cultivated as a commercial enterprise in Iowa for more than 60 years. At one time watermelons were the major truck crop of Muscatine Island and other southeastern Iowa sandy land areas lying along the Mississippi River. It is estimated that 8,000 acres of this crop were grown on Muscatine Island in 1900, but in 1930 the area had dwindled to 850 acres as a result of

wilt disease. The Iowa station undertook an intensive experimental program to develop wilt-resistant varieties. Three such varieties of desirable quality have resulted and seeds of them have been widely distributed to growers. As a result, the acreage of the wilt-resistant varieties, Pride of Muscatine, Iowa King, and Iowa Belle, has steadily increased. Seed of the wilt-resistant varieties is now appearing in the wholesale trade. One Iowa seed company purchased and distributed 2,000 pounds of certified seed in 1932 and 1933. Another significant result of the introduction of wilt-resistant seed has been revived interest and spirit among the melon growers.

Flowers. — A steadily increasing amount of attention is being given by the stations to flowers and other ornamental plants.

The sand-culture method devised by the New Jersey station has been extended to include roses, carnations, sweet peas, larkspur, stocks, gerbera, begonias, cinararia, ferns, *Asparagus sprengeri*, marguerites, Boston ivy, grape ivy, azaleas, and gardenias, with results equal or superior to those obtained in soil culture.

A 1,200-acre narcissus plantation in South Carolina experienced such difficulties in producing normal bulbs that the owners were considering abandoning the enterprise. The South Carolina station found the trouble to be due to deficiency of certain minor soil constituents, such as magnesium and manganese, and recommended the use of basic slag and other materials carrying these deficient elements, with the result that production of bulbs increased from 750,000 in 1931 to more than 8,000,000 in 1933 on the same area. A new industry, which in part replaces cotton, was thus saved.

New Jersey growers of gladiolus corms are rapidly shifting from the old mercuric bichloride soak treatment to an instantaneous dip in calomel to control scab, as a result of experiments by the New Jersey station. In the station experiments the latter treatment has consistently given a much higher percentage of disease-free corms. This is of advantage for intrastate and interstate shipments, and particularly for shipments to Canada, where strict inspections are in force.

Three of the largest commercial growers of rhododendrons and azaleas in New Jersey are using with success for control of leaf diseases a combination of fungicidal and insecticidal spray recommended by the New Jersey station as a result of its investigations on the subject. Previously, growers of these plants suffered heavy losses in sales because of the unsalable condition of their plants resulting from insect and disease injury.

Prevention of damping-off in greenhouses.— In tests of various soil disinfectants to find cheap and effective means of combating damping-off in greenhouse tomatoes to replace the costly and troublesome steam-sterilization process, the New York (State) station found red oxide of copper applied as a dust especially promising. Proving so satisfactory with tomato seed, the use of the material was extended to the treatment of the seeds of eggplant, pepper, spinach, and other vegetables. Its use for field-sown seed has also given striking protection against disease organisms. The results aroused such interest on the part of New York State vegetable growers that the station's supply of printed information on the method was quickly exhausted and heavy demands were made on the vegetable-disease specialist for further explanation of the new treatment.

Formaldehyde dust has been found, by the Ohio station, to be effective as a means of preventing damping-off in growing seedlings in the greenhouse. Detailed directions for preparation and use of the dust have recently been published by the station.

Control of soil pests.—The garden centipede (*Scutigerella immaculata*), which is a serious pest and very difficult to control, the California station finds can be effectively controlled with paradichlorobenzene, carbon disulphide, or carbon disulphide emulsion. The carbon disulphide can be used at the rate of 145 to 290 gallons per acre without injury to vegetation. The treatment is too expensive for field use and is therefore applicable only to small-scale culture.

Much of the cultivated soil of Florida and other Southern States is infested with nematodes to such an extent that means of control are required for the successful growing of some truck crops. One successful method lies in the growing of a nematode-immune crop under constant cultivation during the summer months, thus starving the nematodes. The Florida station has shown that the crotalarias are practically immune to nematode attack and that they are probably the best available cover crops for use in this method of nematode control.

One ot the most serious problems of the large greenhouse industry of Massachusetts is the control of root-knot nematodes. Until recently the most effective control method in common use was soil sterilization with steam. The Massachusetts station showed treatment of the soil with carbon disulphide emulsion to be especially effective in greenhouse culture of cucumbers and tomatoes, which is a large industry in Massachusetts. Using a home-made emulsion, the treatment can be applied at a cost of $392 per acre, but if commercial emulsion is used the cost is nearly $1,500 per acre. The method is now in general and effective use in greenhouses in Massachusetts.

Failure of truck crops on new ground.—Failure often follows attempts to grow crops on new ground, leading to a general opinion among farmers, especially truck growers, that new ground is not suited to the growing of many crops the first year after clearing. The Alabama station has found that such failure in case of Alabama soils is generally due to deficiency of available phosphorus and an insufficient amount of available nitrogen in the new soils, and has shown that if these deficiencies are corrected, new ground soils may be made productive.

Aiding the canning industry.—The canning industry of Maryland has been helped through the development, by the Maryland station, of disease-resistant strains of tomatoes and the location and testing of disease-resistant sources of spinach and snap-bean seed.

Rust-resistant beans.—Because of the great importance of the bean crop in the United States, representing an annual value of $30,000,000 or more, it is easy to realize the seriousness of any disease or insect pest that cuts down the yield of the crop. Bean rust has been recognized for many years as one of the most destructive of the several bean diseases. In the opinion of many authorities, the disease is one of the chief limiting factors in bean production in many of the commercial bean-producing areas in the United States and other countries. Various control measures, such as crop rotation, and the spraying or dusting with certain fungicides, have been recommended, but they have proved not only impracticable but ineffective.

The Virginia station found certain rust-resistant varieties of beans, but these were lacking in other desirable qualities. The station therefore undertook to produce rust-resistant strains having the desired qualities by crossing the rust-resistant types with Kentucky Wonder and Navy varieties. After carrying these strains through many generations, a dozen or more rust-resistant strains each of the Kentucky Wonder and the Navy type have been obtained. The hybrid strains are breeding true to type with reference to quality as well as rust resistance. Some of them seem to be superior to the parent varieties even if rust resistance is not considered. It is only a matter of multiplying the seeds of these strains now in order to be able to distribute them to the public for commercial use. This has already been done on a small scale.

Improving cabbage production.—The Delaware station has shown how to improve cabbage crops through production of good home-grown seed. A 100-percent heredity heading character has been isolated by the station and this superior strain is now being grown for seed production.

An outstanding strain of the Copenhagen Market variety of cabbage has been developed by the Louisiana station which appears to be far superior for Louisiana conditions to ordinary varieties in uniformity and high percentage of marketable heads. The annual value of cabbage grown in Louisiana is estimated to be about $300,000. It is estimated that general use of the improved strain would increase the marketable heads produced 25 percent. The station has also shown that the yield of cabbage can be increased approximately 50 percent by use of suitable fertilizers.

In 1911 a plant breeder at the Pennsylvania station undertook to improve the yield and the solidity of the Danish Ballhead, a very popular winter variety of cabbage. After 10 years of selection, the Penn State Ballhead was introduced. In numerous tests at the station and around the State this has averaged 6 tons more an acre than other strains of Danish Ballhead. Today it is the standard late variety in Pennsylvania, 3,000 acres being grown in 1932. At $20 a ton this is a gain of approximately $360,000 a year.

Yellows-resistant varieties of cabbage, developed by the Department of Agriculture and the experiment stations, are now being widely grown with a saving to cabbage growers estimated at $1,000,000 annually. The Wisconsin station has been a leader

in this work, but other stations have taken part in it, with the result that resistant strains adapted to a wide range of climatic and cultural conditions are now available. In a recent circular the New Jersey station names no less than seven resistant varieties adapted to that State.

Celery blight.—The great celery industry of Michigan suffered great losses in 1932 and was threatened in 1933 by early blight (*Cercospora apii*). The Michigan station was able, as a result of its previous study of the disease, to forecast a possible outbreak in 1933 and to give timely recommendations with regard to more thorough use of copper dusts or of bordeaux mixture to control the disease, which were effective in preventing serious loss.

Sweet corn.—A new variety of early yellow sweet corn, Gold Cross, originated by the Connecticut (State) station, is being distributed. This is a hybrid, resulting from crosses of inbred strains, and possesses the characteristics of remarkable uniformity and vigor common in crossed corn. Gold Cross fills the need for a yellow corn of high quality, but larger than the bantams.

Sweet-corn growers and canners are showing great interest in a new sweet-corn hybrid, 8-rowed Golden Bantam, developed by the Minnesota station, which is being distributed to growers of corn for canning. It gives high yields and matures early, qualities of special value for the canning industry.

Sweet-corn growers in 17 Southern States and in Hawaii and Puerto Rico are passing judgment on two new sweet-corn varieties developed and distributed by the Texas station. Heretofore roasting ears consumed in the South have been ordinary field corn. The new varieties, Surcropper Sugar and Honey June, provide for the first time sweet-corn varieties especially adapted to southern climate and soils and place the South in a position to ship sweet corn to northern markets weeks in advance of the northern crop, thereby providing the consumer an extended green-corn season and increasing the profits to the producer.

Boron as an essential nutrient for lettuce.—Further investigations by the Kentucky station show that boron deficiency has an effect on lettuce very similar to, if not identical with, the disease formerly known as "tipburn." The addition of minute quantities of boron to cultures after the development of the disease caused the resumption of normal growth.

Cheaper and better mushroom spawn.—The value of the mushroom crop of the country is estimated to be from $5,000,000 to $10,000,000 annually, 80 percent of it being produced in the section adjacent to Philadelphia. One of the most serious problems of mushrom growers has been the high cost and unsatisfactory quality of the spawn. Hitherto the spawn has been grown on compressed flakes of manure. The Pennsylvania station has found that pure cultures of spawn can be grown readily on cooked grain or grain products, and that such spawn can be produced at one third the cost of manure spawn and gives as good or better crops of mushrooms. The estimated saving to Pennsylvania mushroom growers as a result of this study is $100,000 a year.

Control of yellow dwarf of onions.—In the noted Pleasant Valley onion district of Iowa, yellow dwarf, a virus disease causing a yellowing, crinkling, and lopping over of the leaves, resulting in stunted plants, was causing such damage as to menace the industry, which is the leading one of the district. The Iowa station has found methods of control which have greatly reduced the damage from the trouble. These consist essentially of indexing sample lots of sets and mother bulbs for each grower, thereby determining approximately the percentage of infection of the different stocks of bulbs. When infection is found to be greater than 5 percent, the stock of sets is discarded and healthy sets or mother bulbs purchased from a source free from disease. Sets are also grown in isolated disease-free areas, thus producing disease-free sets for planting. By these methods the early appearance of the disease during the growing season, due to infected bulbs, is eliminated, and this in turn prevents the early spread of the disease to healthy plants because there is no source of inoculum.

Keeping onions in storage.—The Utah station has found that early pulling produces the best keeping onions. Onions harvested after new roots have been allowed to grow appear to be a poor storage risk. Apparently the irrigation that produced the largest crop also produced the best keeping bulbs. Onions grown with infrequent and irregular irrigation proved to be the poorest keepers. The time of the last irrigation apparently did not influence the keeping quality of onions

at least during the first 5 months. However, the April figures suggest that those onions deprived of irrigation for the longest period were the poorest keepers. The time of topping within a week after pulling seemed to make no difference in the keeping quality. Onions apparently may be pulled, topped, and bagged the same day without influencing their keeping qualities. Bagged onions appeared to keep better than crated onions. It was evident that the smaller onions kept better than the large ones.

Improved varieties of canning peas.—Wisconsin Early Sweet, a strain of canning peas developed by the Wisconsin station and released to seed growers in 1932, continues to show promise of becoming an important factor in the Wisconsin pea-canning industry. It yields a canned product of decidedly high quality, much superior to Alaska and fully equal to Perfection. It is earlier than Perfection, and is for this reason less subject to injury from dry weather or by aphids.

Improved strains and culture of peppers.—Uniform strains of Long Red Cayenne and Tabasco peppers have been developed by the Louisiana station and seed distributed. The improved strain of Cayenne produces about twice the yield of marketable peppers as compared with that commonly used. It is estimated that these strains will be worth about $200,000 to the pepper industry of the State.

A great saving has resulted to chili growers of New Mexico from the work of the New Mexico station in developing a simple cultural method of controlling fusarium wilt, which eliminates from 50 to 75 percent of the loss from this very destructive disease. The method consists simply of planting the peppers deeply on ridges, thus reducing the danger of the fungus causing the disease coming in contact with the plant through capillary rise of water in the soil under irrigation.

Efficient and inexpensive control of the pepper maggot, an insect which for many years has been a limiting factor in pepper production in New Jersey, has been successfully worked out by the New Jersey station. The pepper-maggot flies are attracted and killed by an invert-sugar bait poisoned with zinc arsenite.

Control of damping-off of spinach.—Large losses in spinach culture on both muck and upland soils occur at times as a result of damping-off. The New York (Cornell) station has secured excellent control of this trouble in the greenhouse and in the field on both types of soil by treating the seed with copper or mecurial fungicides.

The best results were obtained by either soaking the seed for an hour in approximately a 1-percent solution of copper sulphate, or shaking the seed with cuprous oxide powder until it was thoroughly coated, using 1 level teaspoonful of powder to 1 pound of seed, or 1 pound of powder to 65 pounds of seed. * * * The cost of treating seed for an acre of spinach (20 pounds) does not exceed 25 cents.

Improvements in sweetpotato culture.—Recent investigations by the Delaware station have shown that a high-potassium fertilizer derived from muriate or sulphate of potash increases the yield of sweetpotatoes 10 percent and reduces the amount of "rots" in storage over 50 percent as compared with low-potassium fertilizers formerly used, thus permitting more orderly marketing of a crop that has an average annual value of $1,129,000.

The sweetpotato growers suffer heavy losses each year from lack of control of such diseases as scurf, stem rot, and black rot. The New Jersey station has demonstrated that these diseases can be greatly reduced by dipping the sweetpotato sprouts in certain organic mercury compounds recommended for this purpose. The treatment has been widely adopted and growers report increased returns as measured by improved stands and freedom from diseases.

Improvements in tomato culture.—The California station found tomatoes used for canning in that State to be unusually high in solids but sufficiently variable to warrant buying for canning purposes on the basis of total-solids content.

A seedling tomato of exceedingly red color and good flavor especially adapted to the manufacture of tomato juice has been obtained by the New Jersey station by crossing Marglobe and J.T.D. In addition to its fine juice qualities it has the merit of earliness. It is planned to name and introduce this variety after one more season's trials. It is believed that the introduction of this variety will greatly aid the tomato-juice industry, enlarge the market demand for tomatoes, and give the consumer a better product.

Disease is one of the chief obstacles which the Florida tomato grower has to overcome. Experiments by the Florida station have shown that the yield of tomatoes on the lower east coast of that State can be increased more than 50 percent through control

of diseases of the vines by spraying thoroughly every week or 10 days with a 4:4:50 bordeaux mixture. This treatment also reduced the decay of fruit 40 percent in transit or held in storage, and when combined with fungicidal treatment of the fruits after picking Phoma rot and other decays were practically eliminated. The treatment not only greatly increased the yield but made it possible for 40 percent more of the shipped fruit to reach northern markets in good condition.

An effective means of controlling blossom-end rot of tomatoes in greenhouses was found by the Ohio station in a modification of the system of watering used. Large applications of water (3.5 inches per week) at longer intervals practically eliminated the trouble as compared with small frequent applications, in which case 73 percent of the trouble developed.

Grading of vegetables by the producer.—Vegetable growers in the vicinity of Providence, R.I., have had marked differences of opinion as to the advisability of exact grading. Some have felt that exact grading was the solution of the marketing troubles of the nearby growers. Others have felt that it meant additional costs without a sufficiently increased return to pay the costs. The Rhode Island station made a study of the grading, packing, and selling of hothouse tomatoes, from which it concluded that the percentage of the "pick" which met the grade requirements had a great deal to do with whether a profit or loss resulted from exact grading. Exact grading proved to be extremely costly and inadvisable with relatively cheap root crops such as beets and carrots. On some farms exact grading of field tomatoes paid the additional costs and netted a profit; on others it did not.

Improvements in pecan culture.—Contrary to a belief held by some that fertilizers are not necessary for pecan trees, the Florida station found, as a result of several years' experiments, that in practically every case fertilized trees bore much heavier crops than unfertilized trees, and therefore recommends the use of a complete fertilizer for pecans.

The cigar case bearer is a destructive insect enemy of pecans for which there has heretofore been no satisfactory means of control. Recent experiments by the Florida station have confirmed previous results in definitely showing that the insect can be very satisfactorily controlled with a commercial winter wash without injury to the trees.

Pecan rosette is a widespread disease which greatly reduces the yield and the quality of the nuts. The Arizona station found that injecting solutions of zinc salts into the roots and trunks of the trees improved the growth of the trees and may be the means of reclaiming large areas which have been condemned for pecan culture because of the disease.

FORESTRY

Use of lands for forestry and like purposes.—The Massachusetts station calls attention to the fact that as a result of a decline in the land area under cultivation in that State there is considerable land especially suited to recreational and forestry uses which might with advantage be acquired by the State and other public institutions for such purposes in developing a balanced program of land utilization for the State. (See also p. 12.) Considerable progress has already been made in improving the condition of wood lots on many farms, and the station advises the continuation and expansion of this service to secure better utilization of unimproved farm land which now occupies almost 25 percent of the total land area of the State.

Natural regeneration of farm wood lots, the Indiana station finds, is in many cases retarded by too close pasturing. An extensive program of forest planting and improvement is being carried out on 1,200,000 acres by the Ohio station which has distributed more than 20,000,000 seedlings for reforestation purposes.

Soil requirements of Arkansas native pines.—In anticipation of the time when general afforestation and reforestation shall be a reality, experiments are being conducted by the Arkansas station to learn the soil requirements of native pines and thus eliminate the expense and loss of time in planting on unprofitable sites. Certain significant facts have been discovered, as follows: The shortleaf and the loblolly pines do not do well in heavy soils. Soils that would be excellent for farm crops are distinctly not suited to pines. Light, sandy soils are best for these species. The requirement for nitrogen is quite low as contrasted with the high nitrogen requirement for agriculture.

Fence posts.—Pine posts creosoted by pressure were found by the Arkansas station to be entirely sound after 10 years' time. Steel posts were also

found to be sound under similar conditions. Painting proved to be of no advantage. Home creosoting of oak posts prolonged their service 4 years. Creosote proved to be the best preservative, but copper compounds precipitated in the wood killed the fungi of decay, and zinc chloride appeared to be promising for home use. Used motor oil was found to afford considerable resistance to decay, and is recommended in cases where the more expensive treatments cannot be afforded.

Since the disappearance of the chestnut the State Highway Department of Connecticut has imported posts or used concrete fences. The Connecticut (State) station has recently shown that several other native trees are stronger than chestnut, and, by proper treatment with creosote, can be made to last as long. The results of the station's tests have been accepted by the highway department, thus providing farmers a market for several hundred thousand posts.

SPRAYS AND SPRAY RESIDUES

The use of dusts and sprays containing such poisons as arsenic and lead to protect fruits and vegetables against insects and other pests has given rise to the so-called spray-residue problem, which is causing serious concern because of the possible menace to health and injury to markets for the sprayed products. The stations have been active in efforts to find effective substitutes for the objectionable poisons, reduce the necessary dosage, apply effective preventive measures, and perfect methods for removing the residues from the sprayed fruit.

Nicotine tannate, a product developed by the New Jersey station, has been tested by the station with encouraging results under local conditions as a substitute for lead arsenate and lead arsenate combined with oil for the control of the codling moth.

Nicotine and pyrethrum gave encouraging results, in experiments reported by the New Mexico station, when substituted for the last four lead arsenate sprays.

Fish oil added to lead arsenate improved the effectiveness of the spray mixture and reduced the cost as compared with that of lead arsenate alone, in experiments reported by the Washington station. When purchased in quantity and early in the season, the fish oil was bought at approximately 25 cents a gallon. One quart of fish oil was found to be sufficient for 100 gallons of spray material, and often not more than 1 pint was used. The use of fish oil resulted in a saving of from 10 to 20 percent, or more, of the cost of the spray. Among the advantages of the use of fish oil is that it reduces the amount of arsenic and lead used. However, it increases the difficulty of removing arsenic and lead from the sprayed product.

The problem of reducing the dosage of insecticides applied has been complicated by apparent increase in tolerance of poison by certain insects. For example, the codling moth, one of the most destructive insects with which the orchardist has to deal, is, according to the Missouri station, becoming increasingly difficult to control with ordinary sprays. The New Mexico station found that all fruit receiving more than two arsenical sprays exceeded the legal limit of arsenic but, when cleaned with dilute acid, was below the limit of tolerance. Apples receiving not more than two arsenical sprays early in the season were, with one exception, below the tolerance limit at harvest time without cleaning, the residue being washed off largely by rain.

A new method of removing spray residues from waxy and oil-sprayed fruit, developed by the New Jersey station, has proved effective for both arsenic and lead residues under conditions of that State. By the addition of a textile wetting or degumming agent to a hydrochloric acid cleaning solution, it was found possible economically and satisfactorily to remove arsenical and lead residues from apples receiving from 6 to 8 heavy applications of lead arsenate in cover sprays of which from 1 to 4 contained oil emulsion. It was not found necessary to heat this cleaning solution in order to obtain a satisfactory removal of the residues. Hydrochloric acid alone would not remove the residues, nor would a heated solution of alkalis such as have been used extensively in the Northwest for the removal of arsenical residues.

In an effort to find a more efficient washer for removing lead arsenate from sprayed apples, the Washington station has devised an experimental washing machine which appears to have decided advantages over other machines heretofore used in ease and cost of operation and in thoroughness of removal of the residue. A detailed

account of the construction and operation of the machine and of extensive tests of its efficiency has been published by the station.

Preventive measures are being strongly stressed by the stations and the Department of Agriculture. The New York (State) station has found bands treated with beta-naphthol to be 100 percent effective for caterpillars spinning cocoons under the bands. Various protective measures have been tested and recommended by other stations.

PRODUCTION AND USE OF ANIMALS AND ANIMAL PRODUCTS

Practically every feature of the breeding, feeding, care, and management of livestock and the handling of animal products is dealt with in the work of the experiment stations. A few examples of such work, selected more or less at random, are here presented.

FEEDING FARM WORK ANIMALS

Notwithstanding the fact that the number of farm work animals in the United States decreased from 26,430,000 in 1919 to 18,762,000 in 1930 and the number of farm tractors increased from 4,000 to 846,162 in the same time, the proper and economic feeding and care of work animals remains a considerable problem on the farm, the main need being reduction of cost of maintenance.

The possible use of byproducts, such as molasses, and of the cheaper forms of forage to reduce cost of maintenance has been investigated recently by the Louisiana and Michigan stations among others.

Blackstrap molasses as a feed for work animals.—The value of blackstrap molasses compared with corn for feeding work animals has been demonstrated by the Louisiana station. When fed in amounts ranging from 6 to 9 pounds per head per day, blackstrap molasses was equal to corn in feeding value. At the present time blackstrap molasses is valued in Louisiana at less than 0.5 cent a pound and corn at over 1 cent a pound. The saving from the use of Louisiana molasses in feeding mules would amount to 4 or 5 cents per head per day.

Wintering draft colts.—The Michigan station has found that draft colts may be maintained on shock corn, but if they are expected to gain in weight some pasturage and hay in addition is necessary.

FEEDING AND MANAGEMENT OF BEEF CATTLE

Artificially dried hay.—Interest in artificial curing of hay has led to study of the effect of the process on the nutritive value of the product by a number of experiment stations, the Louisiana, Nebraska, New Jersey, Pennsylvania, and Wisconsin stations being among those recently reporting on the subject. (See also p. 24.)

In a comparison of machine-dried and field-cured soybean hay the Louisiana station found the machine-dried hay to be highly satisfactory for fattening beef cattle. One hundred pounds of machine-cured hay proved equal to 147 pounds of long hay cured in the field. The gains on steers fed machine-cured hay have been from 10 to 15 percent higher than those fed cut field-cured hay. An artificial hay drier has been developed by the station whereby a first-quality hay can be produced at an economical figure, regardless of weather conditions at harvest time.

Artificial drying of alfalfa hay, the Nebraska station finds, produces a hay containing more vitamin E (the vitamin particularly concerned in reproduction) than that secured by field curing.

The growth-promoting vitamin A content of machine-dried alfalfa was found by the New Jersey station to be not less than that of freshly cut material from the same field, and was from 4 to 10 times that of field-dried material. In the field-curing process there was a progressive destruction of carotene, chiefly during the hours of daylight, so that during the first 24 hours of exposure there was a loss of more than 80 percent of the original carotene content. The results suggest that domestic animals may not get a sufficient amount of vitamin A from field-cured forage crops during the winter months.

Artificially cured or dehydrated alfalfa hay was found by the Pennsylvania station to contain more vitamin A but less antirachitic vitamin D than sun-cured hay. These differences are of economic importance to stock raisers because of the fact that machine curing of hay appears likely to be more generally practiced.

In comparative tests of methods of artificial drying of alfalfa hay the

Wisconsin station found little evidence of the harmful effect of the process on the availability of dry matter, protein, and calcium. Apparently the high heating to which the green alfalfa had been exposed in the quick-drying process had not reduced the availability of these nutrients.

Silage as cattle feed.—In experiments to find more economical methods of fattening steers, the Pennsylvania station showed that the cost could be reduced $2.50 per animal by including corn silage in the ration. The average number of steers fattened annually in Pennsylvania is 75,000, and it is estimated that at least 60 percent of these now receive the silage ration recommended by the station, representing an annual saving of $100,000.

Silage made from corn-cannery refuse, of which little use has heretofore been made, was found by the Illinois station to compare favorably in nutritive value with silage made from standard varieties of corn. On account of its low dry-matter content, however, its value as cattle feed was below that of standard corn silage, and when used as the only feed it proved unpalatable in some cases.

Wheat as cattle feed.—The recent low price of wheat has led many experiment stations to study its value as a feed for cattle.

A mixture of two thirds wheat and one third ground corn fed with or without silage has been found by the Kansas station to be fully equal to ground corn alone. Such a mixture proved to be more palatable than ground wheat alone and more easily fed. A mixture of one third ground wheat and two thirds ground corn fed with or without silage was found to be also equal to ground corn. The substitution of ground wheat for two thirds of the ground corn resulted in carcasses similar in every respect to those of steers fed ground corn alone and superior in most respects to those of steers fed ground wheat alone.

Wheat was used as a complete and partial substitute for corn in rations for fattening cattle in experiments reported by the Missouri station.

Cattle consumed slightly larger quantities of whole wheat than of shelled corn, but gains were not as rapid and, therefore, less economical. Grinding wheat coarsely as a feed for fattening cattle increased the value of this grain approximately 10 percent. Ground wheat substituted for as much as half the full ration of shelled corn fed fattening cattle produced slightly more rapid and economical gains and fully as highly finished carcasses. When ground wheat was substituted for all the corn, cattle consumed less grain, gained less rapidly, produced carcasses of less finish, but the gain was more economical. Bloating, scouring, and other digestive disturbances occurred more frequently when wheat constituted the sole grain ration.

For this reason the station recommends that cattle be put on the wheat ration slowly, and suggests that better results are likely to follow if some other grain is mixed with the wheat during the early part of the feeding period. Feeding silage and a variety of other roughages also seemed to lessen difficulty from digestive disturbances.

Phosphorus deficiency in sugar-beet byproducts feeds.—In a study by the Utah station of the effect of certain protein concentrates and phosphorus-carrying feeds and minerals when fed with a basal beet byproduct ration to fattening cattle, it was found that in beet byproduct rations there is apt to be a deficiency in phosphorus, and the use of phosphorus supplements may be expected to increase the phosphorus content of the blood. Results further indicate that the use of phosphorus supplements may be expected greatly to increase the appetite, gains, and efficiency of gains in fattening beef cattle. Steamed bone meal (tricalcium phosphate) was used in these feeding trials. Apparently it furnished a satisfactory supply of the desired mineral. On the basis of these results, sugar companies are being advised to impregnate their wet and dried pulp and beet molasses with bone meal or with a monocalcium phosphate.

Mineral supplements for livestock.—From an intensive study of the feeding of mineral supplements to livestock, the Illinois station concludes that minerals should be fed to livestock only as supplements to rations that have been properly balanced in other respects, particularly in respect to protein.

The proper use of protein-rich supplemental feeds will improve the productive value of farm rations far more than will the use of mineral mixtures, and at the same time it will reduce the need for minerals or may even supply all the minerals needed. Although animals need a large number of mineral substances, ordinary farm rations supply most of them in more than the amounts required, and it is only under special conditions that mineral supplements are really needed. In fact, for certain classes of livestock, they are needed rarely, if at all. Mineral supplements, therefore, need contain only a few minerals in which farm feeds are known to be deficient, and these can be supplied cheaply and mixed on the farm.

Reducing freight rates for livestock.—As a direct result of an investigation by

the Virginia station of cost of marketing livestock in Virginia, with particular reference to the marketing of cattle and sheep, the railroad which handles the bulk of cattle shipments from Virginia reduced its minimum carload rates considerably, effective May 8, 1933, which will mean an annual saving of $12,000 a year to livestock shippers in Virginia.

Early fall marketing of fat cattle.—The advantage of marketing fat cattle in the early fall rather than feeding and marketing them later was demonstrated by the Kansas station under the conditions prevailing in 1932. Cattlemen followed the advice of the station in this matter with marked profit to themselves and to others, including consumers. By earlier marketing, competition on the November–December market was reduced and better prices were maintained. An additional supply of beef was also made available at a time when there was a relative shortage, thus lowering the cost of beef to the consumer.

DAIRY COWS AND DAIRYING

Cost of producing milk.—A study made by the Rhode Island station indicates that the average cost of milk production in that State during the past year was $3.13 per 100 pounds, or 6.7 cents per quart. The feed requirements per 100 pounds of milk produced were 77 pounds of silage, 8 pounds of other succulence, 99 pounds of hay, and 43 pounds of grain. The cost of this feed was $1.93. In addition, 2.5 hours of man labor, 0.03 hour of horse labor, and 1.2 miles of truck use were required, which cost 88 cents. The net cost of replacing discarded cows from the herd was 29 cents per 100 pounds of milk; interest, taxes, and other overhead costs were 34 cents; and electricity, bedding, and other items, 8 cents. The gross cost was $3.52 per 100 pounds of milk. Credits for manure and net inventory increases were 39 cents, leaving a net cost of $3.13. The study provided specific information which was used (1) by farmers in making adjustments and reducing costs on their own farms; (2) by the sales committee, representing fluid-milk producers, to support their position in negotiations with distributors regarding price, and in answering consumers' requests for lower prices; and (3) by individual farmers retailing their milk or selling in a special market, to help them retain that trade when faced with cut-price milk of lower quality.

Use of labor on dairy farms.—In a study on wholesale milk farms, the New Hampshire station found that—

> chore work in caring for cows varied from 78 to 241 hours per cow. The men with low chore hours per cow had more convenient barns, used better methods, and organized the work more skillfully. Detailed chore records indicate that some dairymen are very skilled and efficient in barn work. On one farm two men took care of 60 cows and 40 head of young stock. However, even the most efficient in some one practice are often inefficient in some other respect. The benefits from greater efficiency in chore work may accrue in the form of more leisure, larger output, or less hired labor. On individual farms the output per man as measured by output units varied from 103 to 452. This difference is due largely to the more constant use of available labor on productive enterprises, better management of labor, more adequate equipment, higher quality cows, more skill in arranging a cropping system and in a more adequate pasture program.

Dairy-farming adjustment.—The results of a study of dairy-farm management by the Delaware station are proving of value to dairy farmers in that State in readjusting their farming systems to new economic conditions brought on by the fall in prices. Recommended practices based on the station's investigations make it possible to treble the carrying capacity of pastures and to provide continuous summer pasture (p. 25), thus practically eliminating summer barn feeding and materially lowering the cost of producing milk.

Silage as a dairy feed.—From experiments with widely different varieties of corn and soybeans extending over many years, the New York (Cornell) station concludes that—

> all things considered, it seems that a combination of the two crops, corn and soybeans, is a practice to be highly recommended to the dairymen of New York as a means of improving the silage, increasing production, decreasing the amount of concentrates necessary, and improving the land—all of which tend to decrease the cost of production.

Good silage, high in protein and mineral matter as compared with corn silage, has been prepared from soybeans by the Florida station. The silage was fed without tainting the milk produced. While the mineral content varied with rainfall, the soybean silage was found to contain, as a rule, about four times as much mineral matter as corn silage.

Sorghum silage has been found by the Texas station to be a poor source of vitamin A for milk cows. Cows fed the silage produced a butter poor in vitamin A.

Dried grass as a substitute for grain for dairy cows.—Artificially dried young

grass replacing a part of the usual roughage (timothy hay, corn silage, and green grass in season) has been found by the Vermont station to be an efficient substitute for grain in the ration of high-producing cows. One cow on such a ration produced 11,044 pounds of milk and 388 pounds of butterfat from March 3, 1932, to January 16, 1933, and was in excellent physical condition and full production at the end of that period. The experimental results "indicate that when two thirds the usual amounts of hay and silage are fed, the average cow can consume sufficient quantities of dried grass for 40 pounds of milk daily, but that, owing to the bulkiness of the ration, any production in excess of this amount would have to be maintained by grain feeding." The practical value of these findings must be determined by the cost of preparing the dried grass as compared with the price of grain fed.

Effect on dairy cows of roughage deficient in lime.—Grasses and other forage crops and silage crops grown on certain acid sandy soils of Florida have been found by the Florida station to contain relatively small amounts of calcium. Dairy cows depending upon roughages grown under these conditions suffer from mineral deficiency and are weakened and made an easy prey to disease. Less milk is produced even when the cows receive liberal amounts of protein concentrates. The station found that addition of 2 percent of bone meal to the concentrates and a daily allowance of 5 pounds of alfalfa hay per cow resulted in a material increase in milk production.

Phosphorus deficiency in dairy rations.—Experiments conducted by the Minnesota station show that including phosphorus in the ration of dairy cattle suffering from a lack of that element increases milk production in some instances as much as 150 percent. In addition, it has been shown that when dairy cattle were suffering from a lack of phosphorus in the ration it required about 40 percent more feed to produce 100 pounds of milk. It is estimated that by including phosphorus in the ration of dairy cattle in the parts of the State affected by phosphorus deficiency, the number of dairy cattle could be reduced by more than one third their present number and still maintain the total milk production of the area. It has been estimated that the lack of phosphorus in the dairy ration probably cost the dairy farmer in these districts over $1,000,000 during the last 5 years. (See also p. 50.)

Feeding value of peas for dairy cows.—In experiments by the Washington station to determine the feeding value of peas in a concentrate mixture for lactating dairy cows, it was found that 500 pounds of pea feed was equal to 400 pounds of wheat bran and 100 pounds of linseed meal for milk production. Washington, Idaho, and Montana since 1929 have produced over 61 percent of the dry field peas produced in the United States, or over 2,000,000 bushels. Of the dry peas as they come from the thresher, about 15 percent are weevily and otherwise damaged peas unfit for human consumption. In the pea-splitting industry, 12.5 percent of the weight of cleaned peas are hulls that are not used for human food. These two byproducts make up a large tonnage of material available for livestock feed. In the pea-splitting plants the weevily and damaged peas and the hulls are ground and combined in about equal amounts. This pea feed can be used with good results, as demonstrated in these experiments.

Use of cotton byproducts as dairy feeds.—In order to obtain a better utilization of cotton byproducts, the Louisiana station made a series of experiments with the following results: It was found that 206 pounds of whole cottonseed was required to replace 100 pounds of cottonseed meal in a good ration; that cottonseed fed only with legume hay in dry lot or on pasture was not a satisfactory ration, and produced a poor quality of butter. Succulent feeds with a small amount of cottonseed gave more normal butter. Cottonseed hulls fed with a high-protein grain, calcium carbonate, and succulent feed were found superior to upland grass hay, about equal to choice Bermuda hay, and inferior to mixed clover hay for winter milk production. A ration of cottonseed meal, yellow corn, oyster-shell flour, and silage was equal to a complete grain ration, silage, and legume hay, and, being produced locally, was more economical. These results are considered to be of value not only to dairymen but to cotton growers as well.

That cottonseed meal can be used as the chief source of protein in rations for growing and lactating heifers without injury to the animals has been demonstrated by the New Mexico station. This is of special value to farmers and dairymen in eastern New Mexico, be-

cause farm rations in that part of the State are very deficient in protein. It is of special value, also, because cottonseed meal is cheap, in comparison with other purchased feeds, in eastern and southern New Mexico.

Grinding feed for dairy cows.—The advantages, disadvantages, and economy of grinding feed for dairy cows and other farm animals have been investigated by a number of experiment stations.

Pulverizing grain did not pay, in experiments with dairy cows reported by the Indiana station, because the gain in utilization of the nutrients in the finely ground grain was not sufficient to pay the cost of grinding. Calves fed ground grain consumed approximately one fourth of a pound more grain per head daily than those fed whole grain, but with no significant difference in gain in body weight and growth in the two lots. Coarse grinding of grain was found preferable to fine grinding in experiments reported by the Oklahoma station.

Importance of vitamin D in nutrition of calves. — As the Wisconsin station points out, calves need vitamin D in their feed to prevent rickets. Deficiency of this vitamin is manifested in a reduction in growth, stiffness, progressive emaciation, and deformity of the bones and enlargement of the joints. The station found oxidized cod-liver oil, ultraviolet radiation, and sunlight to be effective means of preventing rickets, and that a liberal amount of sun-cured hay of the kind and grade suitable for feeding calves supplied an abundance of vitamin D in the ration.

Soft-curd versus hard-curd milk.—Further study of soft-curd and hard-curd milks was reported by the Utah station during the year. The development by the station of a simple means of determining the hardness or softness of milk curds makes possible wide practical use of the information secured in this study. The Wisconsin station has found that soft curd may be a result of disturbed udder conditions, as in case of mastitis, and suggests that in selecting soft-curd milk care must be exercised to be certain that the milk is normal.

Effect of pasteurization on cream layer.—The consumer likes to see a deep cream line on the milk bottle. Milk distributors, however, have found it difficult to preserve the creaming qualities of milk when the latter is subjected to pasteurization. As a result of a study of the effect of different pasteurizing temperatures and lengths of time of heating upon the creaming property of milk, the New York (State) station has developed standards that insure a sanitary product from the public health point of view without seriously reducing the creaming ability of the milk. At the time this work was done little thought was given to its possible bearing on milk-plant operation. Recently, however, dairy-equipment manufacturers have brought out new apparatus that control the temperature of milk in the pasteurizing vat within the limits of one fourth of a degree Fahrenheit. With this accurate temperature control and with the timing of the pasteurizing operation easily controlled, it is now possible to produce a pasteurized milk with a maximum cream layer. Indications are that the method will be generally adopted by the milk industry.

Tallowy flavor in milk and cream.—Tallowy flavor, one of many things that may detract from the quality of market milk and cream, has recently been studied by the Illinois station, with the result of showing that the trouble, which is due to oxidation of butterfat under improper conditions of storage and handling, may be corrected by adding living yeast and homogenizing at 40° F. The station also found that contamination with copper salts and immediate storage at 40° tend to increase tallowy flavor. The station recommends storage at 68° to 90° for 1 to 6 hours before cooling to 40°.

Undesirable flavors and odors in butter.—The market for butter is frequently unfavorably affected by undesirable flavors and odors in the product. The Iowa station has found that butter showing such defects is usually unsalted or low in salt, and that a variety of organisms play a part in producing the defects. It appears from the data obtained that in the manufacture of unsalted or low-salted butter it is especially important to take every precaution to secure efficient pasteurization and to prevent contamination of the cream and butter, if a product with good keeping qualities is desired.

Minnesota markets approximately 3,000,000 pounds annually of unsalted butter. This is a short-keeping product and subject to quick deterioration. Frequently very pronounced and disagreeable off flavors develop in this type of butter and are responsible for losses of more than 2 percent in its

market value. It is estimated that at present prices the losses due to these off flavors amount to from $100,000 to $125,000 per year to Minnesota creameries. The Minnesota station has devised methods of preventing most of these objectionable off flavors, thus improving the keeping qualities of unsalted butter manufactured and greatly reducing losses.

Acid control in Cheddar cheese making.—After many years' study of the subject, the Virginia station has developed an acid-control method of making American Cheddar cheese which appears to be of economic importance especially in the newer dairy territory. The process consists of adding as much as 5 percent of good starter before setting to overcome the effects of undesirable types of organisms usually found in milk as it reaches the factory. The procedure for preventing the excess of acid from spoiling the cheese consists in heavily diluting the whey with warm water immediately after cutting the curd. Usually enough water is added to the whey to reduce its acidity to about 0.12 percent or slightly lower. With milk that contains a very high percentage of acid, the undiluted whey after cutting may contain 0.2 percent or more of acid, and hence a large amount of water must be used to bring the whey back to 0.12 percent. After dilution, the curd is cooked at about 100° F. The object is to dilute and heat the whey and curd so that the dipping acidity will have been reached in from 2 to 2.5 hours after setting.

Consumer preferences in cheese.—Recognizing the fact that any sound program for promoting the use of cheese must be built on an analysis of consumer demand, the Wisconsin station has recorded the reaction of over 8,000 men and women in different parts of Wisconsin and other parts of the United States with respect to flavors of American, Swiss, and brick cheese when mild, aged, or processed. A record was also made of amounts of the different kinds of cheese consumed by a group of 250 young women and a group of 425 young men served with cheese of each kind and quality for 7 consecutive days. The station found that contrary to what is commonly supposed, the quality of cheese bears little or no relationship to the price the consumer pays for it. The grading of 161 samples of mild American cheese purchased from retail stores indicated that variations in prices were not associated with variations in quality.

Use of dry skim milk in cottage-cheese making.—The Missouri station has found it possible to use reconstituted skim milk in making cottage cheese very comparable with that made from normal milk. The reconstituted skim milk used was made by stirring the dry skim milk into water at 90° F. at the rate of 1 pound of the milk to 9 pounds of water for spray-processed skim milk, and 1¼ pounds of dry skim milk to 8¾ pounds of water for vacuum drum-processed milk. This discovery is of considerable importance because cottage cheese is a valuable food product highly esteemed by the consuming public, and the supply of normal skim milk suitable for its manufacture is inadequate during certain seasons of the year.

Use of corn sugar in condensed milk.—By showing how corn sugar may be used in sweetening condensed milk, the Illinois station appears to have opened "a possible new outlet for more than 307,000 bushels of corn, or an average Illinois crop from about 9,000 acres." Universal use of the method by condensed milk manufacturers of the State, it is claimed, "would increase the consumption of corn sugar in Illinois alone by about 8,000,000 pounds. Successful methods of using corn sugar in the manufacture of ice cream, of which Illinois produced more than 16,000,000 gallons in 1931, also have been worked out."

Improvement in chocolate ice cream.—The Missouri station calls attention to the fact that "chocolate ice cream ranks second only to vanilla in popularity and many ice cream manufacturers award it first place in the volume of sales during the winter months." For this reason the station undertook a study of the freezing properties, stability, and physical qualities of chocolate ice cream under different conditions of manufacture and found various ways of improving the process and the product. It was shown, among other things, that sugar decidedly influenced the whipping ability of a chocolate ice cream mixture, prolonged the freezing time, induced a lower temperature of the ice cream, and created a physical condition resulting in a lower overrun.

Excess of sugar, however, submerged the true chocolate flavor and caused the ice cream to have a sticky and soggy body, close texture, and impaired stability. There seemed to be a point of balance at which chocolate

flavoring material and the sugar content produced the most desirable true chocolate flavor. Effects of egg powder, aging, and proportion of chocolate flavoring to other materials were also studied.

Marketing milk through ice cream.—The New York (Cornell) station calls attention to the fact that 3 to 4 percent of the milk produced in the United States is used in ice cream. The proportion so used is increasing rapidly, while use for buttermaking and cheesemaking is steadily decreasing in New York. The station recently reported in some detail a study of geographical sources of the milk products used in the manufacture of ice cream and the returns to the farmer for milk used in ice cream, for buttermaking and cheesemaking, and for distribution as fluid milk. Information was also obtained as to the effect of volume of business, kinds of milk products used, and of other factors, on the cost of the milk products used, and variation in sales of ice cream as affected by such factors as seasonal and weather conditions. As would be expected, there were found to be wide variations in sales of ice cream, depending upon the season of the year, day of the week, holidays, and weather conditions. Temperature was shown to have a pronounced effect. Rises in winter temperature above 40° F. appeared to stimulate sales much more than did changes below 40°. In summer, changes in temperature above 70° had the greatest effect. Changes in temperature at week-ends affected sales more than changes during the middle of the week.

Local markets for milk.—The Rhode Island station reported during the year that whereas Rhode Island shipments of milk to Providence had decreased 6 percent between 1929 and 1931 and shipments from Vermont had increased 111 percent in the same period, as a result of investigations and recommendations of the station a changed market condition had been brought about in which local milk receives the preference and a fresher and better-controlled milk supply for the market has been provided. The facts on seasonal variation, showing a change of 18 percent from the low to the high point, have helped materially in establishing a sales plan which has bettered the marketing conditions of all producers shipping milk to Providence and allows for a better fitting of production to demand.

An improved method of marketing cream.—The Indiana station has worked out a method of marketing cream known as the "four-day delivery plan", as contrasted with marketing at weekly or longer intervals, which has been introduced and is now widely used with great benefit to the butter industry.

The 4-day plan has exerted a stabilizing influence upon the butter industry in southern Indiana that has benefited all agencies connected with the industry. Cream producers who produce a quality product are rewarded with a premium. Over a third of a million dollars has been paid in premiums to farmers of 18 Indiana counties during the past 5 years as a result of 4-day grading. The 4-day plan has established a uniform system of buying cream on a grade basis with a tangible standard, the 4-day limit, that cannot be misconstrued by the buyer nor misunderstood by the producer. The quality of cream is improved, thereby making possible the manufacture of a good grade of butter that satisfies the general requirements of the present day consumer demand, and enables the creamerymen to pay the producer a higher price for butterfat.

In the 4-day plan the producer agrees to observe certain specified sanitary precautions and to deliver cream not more than 4 days old.

Disinfecting milking-machine teat cups.—The Kansas and Indiana stations have shown that a 0.5-percent solution of ordinary household lye is just as effective and is generally more economical and dependable for the disinfection of milking-machine teat cups and tubes than chlorine disinfectants. Studies conducted at the Kansas station show that lye prevents rapid deterioration and prolongs the life of the rubber teat-cup inflations, and is more effective for this purpose than sodium hypochlorite solution containing 200 parts per million of available chlorine. It is estimated that the savings in the cost of rubber replacements for the average milking-machine user in Kansas would amount to from $4 to $6 per year as a result of substituting a 0.5-percent lye solution for a sodium hypochlorite solution in the disinfection of milking machines. While the monetary saving effected in the cost of rubber replacement parts is significant, even more significant is the fact that when lye was used as the disinfectant, the rubber surfaces were entirely free from cracks, checks, and surface encrustation. The Wisconsin station has also developed a simple, cheap, and efficient method of cleansing milking machines with a lye solution.

Sterilizing ice-cream freezers.—As an example of one type of service work rendered by the New York (State)

station, the dairy specialists have recently perfected standards for the sterilization of ice-cream freezers that will bring these utensils within the prescribed requirements of the State's sanitary code. The State Department of Agriculture and Markets was called upon to promulgate sanitary regulations pertaining to the manufacture and distribution of ice cream, but lacking accurate information upon which to base these regulations it turned to the station for help. The method recommended by the station consists essentially of steam sterilization followed by rinsing with a chlorine solution (100 parts per million of water).

Electrical sterilization of dairy utensils.—An efficient electric dairy-utensil sterilizer, economical of current, has been devised by the Maryland station and is being manufactured commercially. The station has also devised an electric pasteurizer.

HOGS

Rations for sows.—The Missouri station has found that the concentrates commonly used in sows' rations are inadequate during the reproductive cycle. Sows fed upon rations of varying proportions of corn, tankage, linseed meal, and alfalfa meal, and in some cases cod-liver oil and a mineral mixture, sustained excessive losses in weight and the milk yield was scanty. The litters were unthrifty and underweight. The addition of wheat middlings and wheat bran brought about an enormous improvement, as did the addition of green forage. Apparently, wheat and wheat byproducts have important nutritional properties not possessed by corn. These same nutritional properties also are present in green forage.

Vitamin and mineral requirements of swine.—While it has been shown that swine suffer more from the lack of vitamins and minerals than cattle, horses, or sheep, results of experiments by the Arkansas station showed that there is no need for using expensive commercial vitamin or mineral preparations when growing and fattening swine are given their fattening feeds, including a small amount of supplemental feeds such as skim milk or tankage, along with an abundance of good pasture. Of the vitamins, A is the one most likely to be present in adequate amounts. Both yellow corn and succulent pastures are economical sources of this vitamin. Good pasture is rich in all the vitamins required by farm animals, and farm animals on good pasture need little or no additional mineral matter except common salt. An adequate mineral mixture can be made from ground limestone, superphosphate, and common salt. Such a mixture is very cheap and will give as good results with fattening swine as more elaborate mixtures which are much more expensive.

Hogging off corn and sweetpotatoes.—Hogging off corn has been found by the Louisiana station to be profitable in that State, but hogging off sweetpotatoes was not profitable. Both of these crops need protein supplements to be most efficient and profitable. Soybeans were found to be a good supplementary protein feed. Less supplement was required in the field than in dry-lot feeding.

Soybeans for hogs.—One of the difficulties in hog production in the Southeast has been the finding of suitable forage which would permit the economic production of high-quality pork. Early experiments with soybeans resulted in a very satisfactory production from the standpoint of economy. Where the mature beans were hogged off during the fattening period, soft and oily carcasses were produced, and the farmers producing them were penalized from $1 to $2 per 100 pounds from the top price paid at the time. The South Carolina station began several years ago to use green soybeans as forage for fattening hogs, and found that the late-maturing varieties will furnish green grazing for the entire period. Hogs full-fed corn and fish meal on this forage made very economical gains, and the carcasses produced were satisfactory. This practice is being adopted rapidly by farmers and is enabling them to produce hogs profitably, even when the price is not more than $5 per 100 pounds.

Scabbed barley as hog feed.—In experiments reported by the Wisconsin station, scabbed barley had no injurious effects on cattle, sheep, or poultry and showed approximately the same nutritive value as normal barley, but made pigs sick. The station therefore advises that as a general practice farmers feed their diseased barley to cattle, sheep, or poultry. Further experiments indicated, however, that farmers can safely feed pigs barley that contains as much as 11 percent of scabbed kernels provided the necessary protein, vitamin, and salt supplements are included in the ration.

Cane molasses for hogs.—Cane molasses was found by the Hawaii station to

be as efficient, pound for pound, as barley for fattening hogs when fed up to 20 percent of the concentrate mixture to hogs having an initial weight of 50 to 100 pounds.

Shrimp meal as hog feed.—The Louisiana station has found shrimp meal, a byproduct of the canning of shrimp, which sells at less than half the price of tankage, to be superior to tankage for feeding hogs. Gains of hogs receiving shrimp meal either with or without other supplements were from 14 to 15 percent greater than when tankage replaced the shrimp meal.

Storage of cured pork.—It has been found by the Texas station that wrapping cured pork products and packing the meat in air-slaked lime protects it from insects and other vermin and provides satisfactory storage throughout the year.

Food value and domestic use of lard.—Realizing the great importance of lard as a source of farm income and the relation of the price of lard to the price of hogs, the Iowa station made an exhaustive study of household uses of lard which showed the numerous ways in which it may be used to good advantage in the home.

SHEEP

Sheep farming in southeastern Ohio.—A 3-year study by the Ohio station of sheep farming in southeastern Ohio reveals that 69 flocks which raised an average of 65 lambs per 100 ewes bred had a wool cost of 32 cents per pound, while 68 flocks which produced 100 lambs per 100 ewes showed a wool cost of 20 cents per pound. The low-cost flocks received more feed and care than the high-cost flocks. Their low cost per pound of wool was due to high production of lambs and wool.

Tailless sheep.—The South Dakota station reports the development of a strain of sheep which produces a superior quality of wool and does not require docking. Of the 53 lambs born in 1933, 15 had no tails, 25 had tails from 0.5 to 2 inches, inclusive, 9 had tails more than 2 inches to 3 inches, inclusive, and the remaining 4 had tails from 3.5 to 5 inches long. This achievement is of considerable practical importance, especially from the standpoint of cleanliness and sanitation. The prospect for adoption of the improved breed is thought to be good.

Finishing early spring lambs.—The Tennessee station found that early spring lambs finished on pasture alone, that is, without supplemental feeding of grain or other concentrates, made more economical gains than lambs on pasture with supplemental grain feeding. Carcass grading gave almost identical results for each group. The West Virginia station has found that early lambs, that is, those dropped in January and February and marketed by the middle of June are the most profitable. Such lambs are dropped during the slack time of the year as regards farm work, and more sheep can be handled. There is less loss from parasites and a better price is obtained. It is suggested that it would benefit the sheep industry to grow more early lambs.

Sorghum grain as feed for lambs.—In experiments reported by the Kansas station, sorghum grain (Atlas) plus ground sorghum fodder (Atlas) plus cottonseed cake plus ground limestone proved to be a satisfactory and profitable ration in fattening western lambs for market. The lambs in this experiment topped the Kansas City market. The special significance of the results lies in the fact that they point the way to a new lamb-feeding section—the western sorghum belt—where various grain sorghums are grown in excess of local needs.

Potatoes as a feed for lambs.—Potatoes have been shown by the Washington station to be superior to good corn silage for the production of fat lambs. From 1 to 1.5 pounds of potatoes with 1 pound of grain and 1.5 pounds of alfalfa hay daily produced more rapid gains and fatter lambs than an equal amount of grain and 1.9 pounds of hay. One hundred pounds of raw, unchopped cull potatoes replaced 10.6 pounds of corn and 37 pounds of alfalfa hay in the feed required to produce 100 pounds of gain.

Cull apples as a feed for lambs.—The Washington station has shown cull apples to have practically the same value as corn silage for fattening lambs if not fed in too large quantities. More than 1 pound of cull apples to every pound of grain fed was unsatisfactory. When fed in combination with grain, 100 pounds of cull apples replaced approximately 9 pounds of grain and 35 pounds of hay. As a feed the apples have the handicap of requiring more careful storage than potatoes.

Sugar beet byproducts for fattening lambs.—The Wyoming station states that fattening lambs is general in districts where sugar beets are grown and that this offers a means of marketing locally produced grain, rough-

age, and beet byproducts. As a result of many years' experiments, the station finds that both dry and wet beet pulp can be used advantageously in combination with other readily available feeds such as alfalfa, cull beans and bean straw, barley, and wheat, with the addition of some cottonseed cake, for fattening lambs for market. While cottonseed cake added to a ration of barley, wet beet pulp, and alfalfa increased the rate of gain, the increase was not sufficient at usual feed prices to show a profit for the cake.

Farm fleeces versus range fleeces.—The Utah station has found farm fleeces to be heavier than range fleeces, notwithstanding the fact that range fleeces have been bringing the better price.

POULTRY

Poultry raising is rated a billion-dollar industry in the United States. Moreover, poultry production is a universal interest, including both commercial and farm production. As would be expected, therefore, the problems of poultry production constitute a major feature of the work of the experiment stations.

Producing and marketing good eggs.—Discussing various essential features of the production and marketing of good eggs, the Illinois station states that "in the long run producers will gain either by grading their own eggs or by selling to someone who buys on a graded basis", because the demand for high-quality eggs is growing. Through a careful study of market conditions and farm methods of producing eggs, the New Mexico station has succeeded in overcoming a market prejudice against New Mexico eggs and reestablishing a good market for them. It did this by inducing producers to so modify their methods of feeding and management that eggs of a quality more acceptable to market men and consumers are produced. One of the most important changes brought about to this end was reduction in the use of cottonseed meal, which apparently injures the appearance and storage quality of eggs if used in considerable amount as feed (p. 48).

Simple rations for laying hens.—In experiments reported by the Alabama station, birds receiving a simple ration of corn meal, minerals, and liquid skim milk produced 24 to 27 more eggs per bird during 9 months than those fed the standard complicated ration, with 3.6 cents per dozen greater return above feed cost than was obtained with the complex ration, valuing the home-produced feed at market prices. These results indicate the possibility of profitable marketing of home-grown feeds in the form of eggs.

The poultry industry of Ohio has been benefited by the introduction, by the Ohio station, of the all-mash ration for laying hens, the substitution of legume hays for green feed, and the use of all-night lights.

Vitamin requirements of laying hens.—In investigations reported by the Kansas station, it was found that rations deficient in vitamins A, B, and D reduced the egg production and hatchability of breeding flocks. Alfalfa meal proved to be an excellent source of vitamin A. Rations prepared from the common grains contained an adequate supply of vitamin B. The station found vitamin C not to be essential in poultry rations and, therefore, that succulent feeds that contain this vitamin are not necessary. It was shown that there is sufficient sunshine in Kansas at all seasons to meet the vitamin D requirements of poultry and thus prevent rickets provided the birds are so housed or managed that they receive benefit of the available direct rays of the sun. If, however, this is impracticable, ultraviolet light can be used to meet the vitamin D requirements. Cod-liver oil can be used to serve the same purpose with growing chicks and laying hens.

Ordinary rations, without green feed, the Texas station finds, do not furnish enough vitamin A for maintenance and egg production. In experiments reported by the station, 1 unit of vitamin A in the egg required 6.3 units in the feed exclusive of maintenance, or 33 units per pound per day. Neither ordinary alfalfa hay nor artificially dried alfalfa, fed with yellow corn at the rate of 8 percent of the mash, furnished enough vitamin A for high production and high vitamin A potency of the eggs produced. The station concludes that "laying pullets apparently require green feed to provide sufficient vitamin A for maximum egg production and high vitamin A potency of the eggs."

Rice byproducts as a poultry feed.—Louisiana imports much of the feedstuffs used in poultry rations. An urgent need exists, therefore, that locally produced feedstuffs be utilized to the best advantage. With this in mind, the Louisiana station undertook to determine the value of rice by-

products as feeds for growing chicks and hens. It was found that rice bran, rice polish, and brewer's rice can be utilized with equally good results to replace higher priced wheat, oat, and corn products for this purpose. Use of rice byproducts reduced the cost of poultry rations from 10 to 20 percent, which may be the margin between profit and loss with the poultry flock. The general use of rice byproducts in poultry rations would result in a large saving to Louisiana poultry raisers.

Sardine meal as poultry feed.—Poultry-feeding experiments made by the Maine station showed sardine meal to be antirachitic. As the only animal-protein supplement it sufficed for all vitamin D requirements of the growing chick. A poultryman using sardine meal as recommended by the station lowered his feed cost from $1.45 to $1.20 per hundredweight, or 17 percent, and secured better growth. Due to increasing demand for sardine meal as poultry feed, the price of fish meal rose from $33 to $55 a ton from 1932 to 1933.

Cane molasses for poultry.—The Hawaii station found cane molasses fed in amounts not to exceed 7 percent of the mash ration to be satisfactory for chicks and for growing pullets and cockerels. Use of fattening rations containing 5, 10, and 15 percent, respectively, of the molasses resulted in economical gains with broilers, but in inefficient production with hens in fattening batteries. Fed to baby chicks the molasses appeared to have no effect in preventing coccidiosis.

Peas as poultry feed.—Recent investigation by the Idaho station has demonstrated that peas of the green-seeded varieties such as the Alaska and Bluebell are rich in vitamin A. Ground cull peas of the Alaska variety, fed to poultry at a level of 20 percent of the ration, afforded approximately the same protection against vitamin A deficiencies as did 20 percent of yellow corn. Chick rations consisting of wheat alone or in combination with oats and barley as the grain supplement, and with no vitamin A supplements, proved so deficient in vitamin A that no chick lived beyond 9 weeks of age. When ground peas of the Alaska variety were incorporated at the rate of 20 percent of the ration, adequate protection was afforded against vitamin A deficiencies and normal growth was secured. Ground peas of the yellow-seeded varieties used at 20 percent of the ration proved inadequate and could not be relied upon as a source of this vitamin. The results of this investigation have been of distinct value in reducing cost and increasing the efficiency of poultry production in Idaho. Recommendations based on the information have been made widely available in the State and have resulted in a marked increase in the use of peas in poultry rations.

Ground soybeans for growing chicks.—The Delaware station has shown that ground soybeans supplemented with bone meal can be used with advantage and without affecting the keeping quality of the eggs to replace a large part (as much as one third) of the animal protein (meat scrap) in rations for growing chicks, if a unit of protein in soybeans costs less than in meat scrap. These results are of economic importance both from the standpoint of the poultry producer and from that of finding a profitable use and market for the increasing crop of soybeans in Delaware.

Cod-liver oil for laying hens.—The Kentucky station found that incorporating 2 percent of cod-liver oil in the mash increased egg production and improved hatchability of eggs of hens kept in confinement. Use of the oil was unnecessary in case of hens having sufficient bluegrass range and sunshine (p. 55).

Iodine in poultry rations.—The iodine content of foods and feeds and means of increasing it are matters of considerable importance, especially in regions where the local foods, feeds, and drinking water are deficient in iodine and as a result goiter and goitrous troubles of man and domestic animals are common. The Ohio station found that feeding 2 and 5 milligrams of iodine daily per bird in form of dried kelp, iodized linseed meal, or potassium iodide increased the iodine content of the eggs approximately 75 and 150 times, respectively, the amount of iodine in the eggs being independent of the form in which it was fed. (See also p. 50.)

Increasing the antirachitic vitamin D content of eggs.—The Iowa station has shown that "hens which receive cod-liver oil or viosterol—a concentrated carrier of vitamin D—store more vitamin D in the yolk and thus produce eggs richer in this essential vitamin." It is suggested that poultrymen recognize this fact in producing eggs rich in vitamin D and let consumers know that they are producing such eggs.

Improving the hatchability of eggs.—The Wyoming station has found that under

the extremely dry conditions in that State large amounts of moisture (68–82 percent humidity) supplied at the end of the hatching period produces a great increase in the number of live chicks obtained. The effect of increased relative humidity seems to be purely mechanical; that is, it prevents the premature drying of the chick and the surrounding material and thus prevents the chick from sticking to the shell.

Improved brooding battery for chicks.—A triple-purpose battery, devised by the Ohio station, in which chicks are brooded, grown to the laying stage, and confined during the laying period, gives promise of making possible material savings in necessary poultry equipment.

Sanitary method of rearing chickens.—Poultry raisers of Louisiana who have suffered large losses especially from coccidiosis and internal parasites appealed to the station for a practical means of control of these troubles. As a result of investigation, the station was able to offer a sanitary plan of management using wire floors in the brooder houses, rotated growing ranges, and rotated yards for the laying hens, which has greatly reduced the poultrymen's losses.

Egg marketing.—As already indicated (p. 46), the marketing of New Mexico eggs has been greatly improved by investigations of the New Mexico station into the conditions necessary for the production and marketing of eggs of good quality and precautions that must be taken in shipping and storing eggs. Preliminary data reveal that shipment by express or refrigerator freight are superior to either truck or parcel post, with express shipments showing a slight advantage over refrigerator freight. However, the data are showing methods whereby the quality of truck shipments may be improved. Transportation concerns are much interested in the results, and officials of one large truck company that hauls eggs from eastern New Mexico to California points have asked the station to make a comparison of shipments by common truck and by refrigerated truck.

Consumers' preferences for eggs.—As the Rhode Island station points out, a knowledge of the habits and preferences of consumers appears to be a logical starting point in a marketing program for producers. Such knowledge might also make it possible to improve the consumer's opportunity to obtain what he wishes at lower marketing costs and wastes. A survey by the station of consumers' preferences for eggs brought out the following points: Persons of different nationalities have markedly different habits and likes in regard to eggs. Eggs are used primarily because people like them, because they are considered wholesome, and because they are convenient to prepare. Providence housewives were willing to pay a considerable price premium for fresh Rhode Island eggs in 1932. Brands of eggs, or trade marks, had made little impression upon them. The undesirable qualities found most frequently in eggs were blood spots and bad odor. It is believed that the data obtained in this survey will be of considerable help to egg producers and cooperatives and will furnish a basis for correcting many mistaken ideas about eggs in the minds of consumers.

Consumers' preferences for egg-yolk color and shell color in New York City have been studied by the Missouri station, with the result of showing that slightly more than one third of the 10,358 consumers interviewed expressed a preference for light yolks, one fourth for dark yolks, one fifth for yolks of medium color, and the remaining fifth had no preference, thus indicating that "a price premium for any yolk color is not justified from the standpoint of either consumers or distributors." It was found that "slightly less than one half of the consumers interviewed expressed a preference for white shells. The remainder either preferred brown shells or had no color preference. In some boroughs a majority was in favor of white shells, justifying a price premium, but in others this was not true." The results of this study suggest the need of efforts to make consumers understand that shell and yolk color preferences "have no necessary connection with interior quality." (See also p. 55.)

Production and marketing of turkeys.—The present production of turkeys in the United States is about 19,000,000 birds, and is steadily increasing with improved methods of feeding and management based largely on work of the experiment stations.

The Nebraska station has recently studied and reported upon advanced methods of production and marketing turkeys. The improved methods of management recommended include—

keeping breeding stock confined to fenced areas; the use of incubators for hatching; artificial brooding in clean houses with gravel, screen, or board flooring in

the yards until the poults are 8 weeks old; moving the poults to wire-enclosed roosting sheds on clean range after they are 8 weeks old for the rest of the growing period; full feeding a complete ration with special emphasis on green feed; use of every practical method of providing clean feed, clean water, and clean range.

From the standpoint of marketing, the station states that the qualities which make a dressed turkey most attractive are straight keelbone and no skeletal deformities; plump carcass, well fleshed in all parts; no scabs or bruises; well bled, picked clean, all pinfeathers removed.

Raising turkeys in confinement was found by the Pennsylvania station to be a practicable means of avoiding serious loss from internal parasites and developing more suitable rations. It is stated that, largely as a result of the work of the station, the number of turkeys on Pennsylvania farms increased from 87,400 in 1920 to 175,089 in 1930, and 218,861 in 1932. At least 60,000 more turkeys are raised each year by the methods recommended by the station.

The need of adequate vitamin D in rations for young turkeys to prevent rickets, crooked breast bone, and similar troubles has been demonstrated by the Iowa station. Cod-liver oil (1 pound to 100 pounds of mash), leafy alfalfa, and egg yolk, especially the first, were found to supply the needed vitamin. Abundance of sunlight in addition was also shown to be beneficial.

ANIMAL DISEASES AND DISORDERS

Animal diseases and disorders which increase so largely the hazards and cost in animal production and impair the quality of the product are to a large extent being brought under control or entirely eradicated by such work as the Department of Agriculture and the experiment stations are doing. The progress in this direction has been one of the outstanding achievements of research by these agencies.

Prevention of breeding diseases in horses.—A leading feature of the work of the Kentucky station for some years has been the development of methods of so handling brood mares and foals as to prevent the large losses which result from breeding diseases. For several years the station has made observations and kept records of a group of brood mares and their foals which were maintained and handled for this purpose, and a program of breeding hygiene and parasite prevention has been worked out and followed systematically with a high degree of success. The leader in this work has repeatedly been called to Europe for consultation with horse breeders to assist them in solving particularly intricate and difficult horse-breeding problems which arise from time to time.

Controlling parasites in horses and mules.—Colic in horses and mules due to parasites, the Louisiana station finds, can be practically eliminated if the animals are treated for intestinal parasites semiannually. The station has found that when the animals are free from parasites they show a gain in weight and improvement in physical condition, thus increasing greatly their capacity for work. This information is being used by veterinarians and extension agents, as well as by farmers themselves, with highly satisfactory results.

Encephalomyelitis in horses.—A curative serum for this destructive disease has been discovered by the Nevada station and is now being prepared on a large scale by commercial concerns and extensively used. Recently the station has devised a protective vaccine which is being tested in a practical way with promise of entire success in preventing outbreaks of the disease in animals under severe conditions of exposure.

Infectious abortion.—Infectious abortion is one of the most widespread, persistent, and costly diseases of animals. It has been the subject of much study by the Department and the stations in an effort to find practical means of control or eradication. Methods of detecting the disease have been perfected, and there is a growing movement for the establishment of abortion-free herds by eliminating or segregating reacting animals.

The Connecticut (Storrs) station, among others, has been especially active in perfecting methods for detecting carriers of the disease. This station concludes that the proportion of confirmed reactors which change from positive to negative is too small to warrant an effort to salvage them at the cost of undue risk of reinfecting other animals. As a basis for eradication, the station holds "that a half dozen tests spaced at intervals of about a month are far more effective than the same number of tests spread over a year or more. The object should be to identify and remove the newly infected animal before it has an opportunity to spread the disease."

A recent survey by the Idaho station of all dairy cows in several cow-testing associations showed that 13 percent of the cows reacted positively to the test for abortion. This high incidence of the disease led to the adoption of a State program for its eradication. During 1932 15,000 animals were tested and certificates of accreditation were granted by the State Department of Agriculture to those herds shown by adequate tests to be free from the disease.

The Virginia station found a number of cases of undulant fever in the State, which it traced to abortion in animals, thus emphasizing the importance of boards of health and physicians, as well as veterinarians, knowing the situation and taking steps to eradicate infectious abortion.

Mastitis.—Infectious bovine mastitis has become a major source of loss to dairymen, especially as milk inspection grows more rigid and systems of herd management more intensive. Any system of control and eradication depends on a reliable method for detecting carriers. All of the possible methods are under intensive study by the Connecticut (Storrs) station, and their limitations, particularly those of the bromthymol-blue test, have been determined. The Indiana station has developed a simple and inexpensive so-called "paper test" which appears to be highly efficient as a means of detecting the disease. The New York (State) station has perfected a quick and reliable method for detecting infected animals which is meeting with favor on the part of dairy farmers and veterinarians and has been given wide publicity. This station has also shown azamine, a pyridine derivative, to be good for udder irrigation in mastitis. The Wisconsin station has shown the advantage of careful herd management to control mastitis, which is causing large losses to dairymen in that State.

"Blind staggers" of cattle.—Blind staggers is the name locally applied to a disease that causes large losses of cattle in certain parts of Wyoming. Horses and sheep are also affected. The Wyoming station states that the cause of the disease is very clearly some kind of plant poisoning, although the specific plant or plants have not been definitely determined. However, a treatment which has been found successful consists of the subcutaneous injection of from 5 to 8 milligrams of strychnine sulphate every 2 or 3 hours. Along with the strychnine administrations the animal is drenched generously and frequently with water at 100° to 125° F. in order to sluice out the gastro-intestinal tract. This is continued into the second day of the treatment, and if normal eating is not resumed by the animal forced feeding may be resorted to. (For arrowgrass poisoning see p. 52.)

Rickets in calves.—Several of the experiment stations, including especially those of Michigan, Pennsylvania, and Wisconsin, have shown that deficiency of vitamin D in the ration is a cause of retarded growth and skeletal development (rickets) in calves and young cattle. Comparative tests by the Pennsylvania station of sun-cured alfalfa, dehydrated alfalfa with little or no exposure to the sun, activated ergosterol, exposure of the calves to a carbon arc lamp, devitalized (A and D) cod-liver oil, and oat straw showed that good sun-cured alfalfa hay was more potent in preventing the trouble than artificially dried hay, activated ergosterol was highly effective, 30-minute daily treatments with ultra-violet light from a standard carbon arc lamp cured or prevented the trouble, and oat straw showed a considerable amount of antirachitic potency when fed as a supplement to a good basal diet.

Mineral deficiency troubles.—Deficiency of certain mineral constituents such as lime, phosphorus, iron, copper, manganese, iodine, and others in feed and forage is responsible for poor growth and health of livestock in certain regions where there is a deficiency of these necessary mineral elements in the waters and soils and hence in the locally grown feeds and forage. (See also pp. 17, 40.)

A shortage of phosphorus in forages grown on certain Florida soil types has been found by the Florida station to be the cause of "sweeny" or "stiffs" in cattle. Analyses of forage samples collected in areas where cattle chew bones, oyster shells, leather, and similar materials showed them to contain only approximately 60 percent as much phosphorus as like forages from areas where sweeny does not occur. Autopsies of affected cattle showed the mineral reserves of the skeleton to be seriously depleted. Cows with suckling calves were found to be the most seriously affected. When bone meal was made available to the cattle they consumed from 7 to 9 pounds each per year, improved in condition, ceased chewing on bones or shells, and many of them more than trebled the amount of organic phos-

phorus in the blood plasma. No animals were lost from sweeny in any of the herds receiving the bone meal.

Pasture grasses and silage grown on sandy, acid soils in Florida were found by the station to contain a low percentage of calcium which resulted in a calcium deficiency in cattle that fed on these roughages. This deficiency manifested itself in weakened and broken bones. A bone-meal supplement entirely eliminated further bone breakage in test animals and greatly increased the breaking strength of bones. Milk production of cows fed bone meal was increased 50 percent, the cows being more persistent milkers, particularly beyond the sixth month. The Florida station has also shown that the use of iron-containing supplements with livestock on ranges where the condition called "salt sick" occurs greatly reduces trouble from that cause.

The results of exhaustive studies of mineral deficiency troubles which occur in certain parts of Minnesota and adjacent regions were published during the year by the Minnesota station. The trouble was shown to be due to a deficiency of minerals, particularly phosphorus, in the feeds and forage crops used, resulting in malnutrition, abnormal growth, and lowered production, particularly in dairy cattle. The remedies suggested are to use mineral supplements, preferably bone meal, supplying the necessary phosphorus, or to increase the phosphorus content of locally grown feed and forage crops by the use of phosphatic fertilizers. (See also p. 40.)

A deficiency of iodine is found in certain regions of the United States, corresponding roughly to goitrous regions for human beings, and occurrence of big neck, hairlessness, and similar troubles in new-born animals, including calves, foals, kids, lambs, and pigs. (See also p. 47.) The Oregon station, which among others has investigated this subject, recommends that in goitrous regions pregnant livestock especially should always have access to salt, lime, phosphorus, and iodine. It recommends for this purpose a mixture of sterilized bone meal, finely ground limestone, and potassium iodide at the rate of 5 grains once a week to each animal, 3 ounces of the iodide being dissolved in 1 gallon of water and sprinkled on the feed.

Pig mortality.—It is estimated that of the approximately 4,000,000 pigs farrowed each year in Minnesota 5 percent or 200,000 are lost from so-called "swine anemia." At 50 cents apiece this represents a loss of $100,000 a year to the hog raisers of the State. Most of the losses occur where sows are farrowed in confinement on plank or concrete floors. Investigations by the Minnesota station have disclosed a very simple remedy. It consists of covering a portion of the floor of the pen with fresh mineral soil. This soil should be normal in the mineral elements, particularly iron and copper. The remedy for anemia is so simple and inexpensive that farmers should make wide use of it. The early farrowed pigs especially should be saved if possible to gain timeliness in marketing. Those farrowed later when the pigs can have free run on uncontaminated soil are seldom troubled with anemia.

Stomach worms in sheep.—Studies by the North Carolina station of sanitary measures and temporary pastures for sheep have indicated the possibility of producing lambs without drenching for stomach worms. Lambs produced under sanitary conditions on temporary pasture gained more rapidly and reached market weight earlier than lambs on permanent pasture and drenched.

Infectious bronchitis (laryngotracheitis) of poultry.—The New Jersey station has further perfected and tested its proposed method of artificial infection of the cloaca of fowls with a virus suspension as a means of immunization against infectious laryngotracheitis. In extensive tests the method has proved highly effective with little or no loss as a result of the treatment. The Massachusetts station has also reported results of studies of this disease and has proposed a plan for its eradication and control and also a somewhat different method of vaccination.

Fowl pox.—Fowl pox is a widespread disease, resulting in enormous loss to poultrymen not only in death of fowls but also in reduction of egg production. Further progress in finding effective means of controlling fowl pox was reported by a number of stations during the year.

The so-called "stick" or "Johnson method" of vaccinating against fowl pox gave as good results as the "follicle method" in experiments by the New Hampshire station, and appeared to have the following additional advantages: Birds could be vaccinated at least three times as fast, about one third the amount of vaccine was required, the vaccination reaction of the bird was less, and the number of head

lesions was substantially reduced. The method has been quite generally used with good results by poultrymen.

Early vaccination of chicks, at 1 to 10 days of age, and turkey poults, when 2 weeks old, gave good results in experiments by the Texas station on control of fowl pox. The station suggests "vaccinated chicks" as a new sales idea for poultrymen.

The use of a pigeon-pox virus by the Virginia station is effecting a saving to poultrymen in preventing chicken pox without loss in egg production, which may follow the use of chicken-pox virus, and in checking outbreaks in the incipient stage without severe loss.

The Utah station has found pigeon-pox virus as now manufactured and dispensed to be capable of conferring a considerable degree of immunity against chicken pox. Apparently, however, the immunity is more transitory than that obtained with chicken-pox vaccine.

The Hawaii station reports a high degree of success in immunizing against fowl pox by vaccinating young chicks with "live virus" vaccine prepared by the station. Over 60,000 chicks were so vaccinated, with the loss of only 1 in 20. Screening houses and runs against mosquitoes has been found to be effective in preventing spread of the disease among chicks.

Hock disease or slipped tendon in fowls.—That this disease, which has caused serious loss to poultrymen, is due to unbalanced mineral content of feeds appears to have been well established by the Ohio and Pennsylvania stations and the Department of Agriculture. The Pennsylvania station finds the feeding of ground oats a helpful means of reducing the trouble.

Prevention of blackhead in turkeys.—By practicing sanitary precautions to prevent fecal contamination, the Nebraska station has found it possible, within the range of economic possibility, to create an environment in which the blackhead hazard for turkeys can be reduced to a negligible minimum. The essential features of the plan are to cover the lots in which the poults are kept with coarse gravel over which wire panels are placed to prevent fecal contamination and the swallowing of excessive amounts of contaminated gravel. The station's investigations have strongly confirmed the view that contaminated soil, feed, and water are the dominant factors in blackhead infection; in other words, that blackhead can be definitely classified as a filth-borne malady.

A simple remedy for internal parasites of poultry.—The Arkansas station has found a combination of 15 grains of kamala and 5 drops of nicotine sulphate given in one capsule to be a simple and effective means of removing both tapeworms and roundworms from affected birds in that State. A distinct drop in egg production followed each treatment, but the intensity of the production cycle of the treated pullets was increased following these periods of low production. Hatchability or weight of eggs was not influenced by the treatment. In view of the high percentage of fowls infested with internal parasites, the discovery of a simple and effective treatment such as this appears to be is a matter of much practical importance.

Chenopodium as a vermifuge.—Results of studies in progress at the South Dakota station indicate that chenopodium offers a means of materially reducing the cost of worming domestic animals. It was found that animals feeding on the herb as it grew in the field satisfactorily wormed themselves. From these results it appears that farmers generally may grow their own wormseed plant and thus secure efficient worming of their animals at a greatly reduced cost. Production of wormseed plants has previously been restricted almost exclusively to a small territory in Maryland and a few counties in Indiana.

Plant poisoning. — The range plant known as *Drymaria pachyphylla* has been shown by the Texas station to be poisonous to sheep and probably other livestock. This station has also reported upon the poisonous qualities of two distinct species of loco weeds.

The Wyoming station has demonstrated the effectiveness of methylene blue and sodium tetrathionate as antidotes for poisoning by arrowgrass. It is thought that this discovery will enable stockmen to prevent considerable losses which now result from this cause. (See also p. 50.)

Differentiation of animal and human streptococci.—By the use of methods developed by the Kentucky station, it is now possible to distinguish streptococci of human and animal origin with a high degree of accuracy, thus furnishing a means of determining whether in certain cases diseased animals may not be carriers of human diseases. For example, the station has been

able to definitely differentiate *Streptococcus epidemicus*, the cause of septic sore throat in the human, from certain closely related strains of streptococci of animal origin. Both strains are found in the udder of cattle, and, therefore, differentiation is important in outbreaks of infectious mastitis of cattle and of septic sore throat in the human.

RURAL-HOME AND RURAL-LIFE BETTERMENT

Station work relating to rural-home and rural-life betterment benefits both rural and urban people, especially in such matters as better and more dependable food supply, increased knowledge of food requirements, more efficient household methods and appliances, improved living standards, better health conditions, and in many other ways. Much station work not undertaken with these as primary objects has nevertheless contributed to them.

The following examples represent only a few recent contributions of the stations to rural-home and rural-life betterment. Other sections of this review contain much that has an important bearing on the subject, and many more equally significant examples of station work specifically related to it might have been cited.

Vitamins essential in foods.—The value of vitamins in human nutrition, as well as in the feeding of domestic animals (p. 37), has been the subject of much investigation by the experiment stations ever since the early days in which the stations contributed so much to the discovery of the vitamins. Many technical and popular bulletins and articles, as well as some notable books based largely on station work, have been published. One of the recent contributions to the more permanent literature of the subject is a book by Barnett Sure entitled "The Vitamins in Health and Disease", which is based in large part on station research, particularly that of the author at the Arkansas station.

It is now possible to compare many foods for their relative content of certain vitamins, particularly vitamin A, the lack of which results in widespread weakening of the body and of its ability to resist infection, and vitamin C, which prevents scurvy as well as more minor symptoms of poor health. The Texas station has made a very useful contribution along this line in a bulletin entitled "Vitamin A Content of Foods and Feeds." Here are to be found tables, based partly on results of studies carried on at the station and partly on previously reported data from many different sources, showing the approximate number of units of vitamin A in many different foods and feeds both in their natural state and after storage and preservation, and also the relative cost at current prices of a given number of units of vitamin A in many of the more common foods. A still more graphic comparison of the relative value of different foods as sources of vitamin A (and vitamin C as well) is to be found in a circular from the West Virginia station in which charts are given showing the relative quantities of these two vitamins in customary servings or portions of the more common foods. This circular also summarizes in a simple, concise manner the distinguishing properties and functions of the vitamins.

Food products of more or less regional interest continue to receive attention in vitamin-content studies at the stations. The apple is a fruit which appears to vary widely in its content of vitamin C. It is consequently of value to both consumers and producers to know what varieties of apples are especially good sources of vitamin C.

The Baldwin apple was reported by the Massachusetts station to be a particularly good, and the McIntosh a less satisfactory source of vitamin C. Studies at the Washington station showed that the Winesap apple, as grown in that State, is a fairly good source of vitamin C. There was some indication that proper fertilization tended to increase to a slight extent the vitamin C content of the apple. It was also found that the vitamin C content of apples was preserved successfully for 6 months or more in cold storage, whereas some loss occurred in common storage.

Fresh strawberries of the Howard Supreme and Klondike varieties were found by the Massachusetts station to be an excellent source of vitamin C. Freezing the berries with or without sugar and incorporating them in ice cream had no harmful effect on the vitamin C content—an important point in connection with the extensive use of frozen strawberries in ice cream, sundaes, and other desserts. Cranberries, on the other hand, were found by the Massachusetts station to be very sensitive to certain com-

mercial and household processes. (See also p. 30.) For example, the only safe course for the homemaker to follow in the preparation of cranberries for holiday dinners is to make the old-fashioned unstrained sauce, for straining tends to destroy to a marked degree the vitamin C content of cranberries. Cranberry juice, pleasing as it is in appearance and taste, is a poor substitute for orange or tomato juice as a vitamin C appetizer.

The ever lengthening list of foods, the vitamin values of which can be stated more or less quantitatively, contains many items resulting from experiment station work. Highbush blueberries fairly rich in vitamin C and lowbush berries low in vitamin C, the pimiento pepper exceptionally rich in vitamin A, the New Mexico pinto beans a good source of vitamin B, are recent items coming from the Massachusetts, Georgia, and New Mexico stations, respectively. Many other illustrations might be given of contributions which the experiment stations are continually making to knowledge of the vitamin content of foods in the natural state and as affected by the various treatments which they undergo before consumption. The ultimate goal in all this work, as it affects the consumer, is complete knowledge of the vitamin content of all foods in the condition in which they are commonly eaten.

Increasing the vitamin D content of milk.—Increased knowledge of the composition of the more staple foods, as well as of nutritional requirements, has shown that some foods formerly considered as almost perfect are capable of improvement. Milk is such a food, and the essential constituents with which it is not well provided include certain minerals, particularly copper and iron, and certain vitamins, particularly vitamin D, the vitamin which is necessary for the utilization of calcium and phosphorus—the essential elements of the bones and teeth, and other tissues. It is partly because of the low content of vitamin D in milk that rickets has been so widespread among children. Vitamin D is essential not only for normal growth and development of the bones and teeth in children, but for their protection in adults, and for the prevention of various disturbances of calcium-phosphorus metabolism. It is the vitamin, moreover, which is most lacking in foods in general.

It is possible to increase the vitamin D content of milk to a limited extent by proper feeding. The Michigan station found that cows on Sudan grass pasture in summer and fed second cuttings of alfalfa hay with an adequate grain ration in winter produced milk well supplied with this vitamin. The station considered sunlight and sun-cured hay among the most important practical means of maintaining the vitamin D content of milk.

Thanks to the discovery at the Wisconsin station that certain foods can be enriched in vitamin D by suitable exposure to ultraviolet light, and to concerted attack at various experiment stations and elsewhere on the most practical means of increasing the vitamin D content of milk, many milk dealers throughout the country are now distributing milk enriched in vitamin D in various ways.

The possibility of increasing the vitamin D content of cow's milk by feeding the cows some vitamin D concentrate has been demonstrated by the Ohio, New Jersey, and Wisconsin stations. The Ohio station found that the vitamin D content might be increased by feeding concentrated cod-liver oil or irradiated ergosterol, but that both methods are too expensive for practical use. All three stations have reported success with feeding cows irradiated yeast, and vitamin D milk prepared in this way is now being sold in many cities.

Most recent work at the Wisconsin station, as well as in commercial laboratories, has led to the conclusion that direct irradiation of the milk is the most practical and inexpensive means of increasing its vitamin D content. Working with manufacturers of carbon arc lamps and dairy equipment, the station has developed various devices capable of irradiating milk on a large or small scale, with a resulting product approximately four times as rich in vitamin D as normal milk and with no change in flavor. For large distributors the cost of this process is very small, only a fraction of a cent a quart. Preliminary work, also at the Wisconsin station, has shown the practicability of using the process to increase the vitamin D content of evaporated milk and of cheese. Commercial use of the process of preparing irradiated milk and other food products enriched with vitamin D is controlled by the Wisconsin Alumni Research Foundation.

Supplementing the minerals of milk.—Milk, as the Wisconsin station points out, is generally considered more

nearly a complete food than any other single food material in common use. However, it has never been possible to rear experimental animals from weaning to maturity on milk alone. After a few weeks on an exclusive milk ration the animals lose weight and die of anemia. This has been attributed to the low iron content of milk, but the Wisconsin station has shown that milk is also deficient in copper, which is indispensable in the nutrition of mammals and as a supplement to iron in the formation of hemoglobin in the blood. More recently the station has demonstrated that the addition of traces of manganese to a diet of whole milk supplemented with iron and copper has a favorable effect on growth and reproduction. Pigs made greater growth on the mineralized milk alone than on a standard mixed ration, and rats grew and reproduced normally through four generations on an exclusive diet of mineralized milk.

While no one would advocate mineralized milk as the sole diet for human beings after early babyhood, these experiments emphasize the need of early supplements to milk in infant feeding. The question is sometimes raised as to whether or not pasteurization affects the mineral content of milk. The Ohio station found that rats did not develop anemia any more quickly on pasteurized milk than on raw milk, showing that there was no loss on pasteurization of the small amounts of these elements present in raw milk. It was also found that the availability of calcium and phosphorus of the milk was not affected by pasteurization, but that at least one fourth of the antineuritic vitamin B originally present in the milk was destroyed. Another question sometimes raised by anxious housewives is the effect which freezing may have on the nutritive value of milk. The Maryland station reports that freezing, while altering the physical appearance of milk, does not reduce its nutritive value.

It is now considered good infant-feeding practice to supplement milk fairly early with orange juice, egg yolk, cereals, and strained vegetables. Part of the benefit from these additions is undoubtedly due to the same minerals, copper, iron, and manganese, that proved so effective in the Wisconsin pig-feeding and rat-feeding tests. This was demonstrated by the Wisconsin station in a comparison of the hemoglobin curves of the blood of a large number of children from birth to 5 years of age with that of a small group which had been given a special diet rich in minerals. Although there was no difference during the first 6 months, from then on the hemoglobin values of infants receiving the supplement rose more rapidly than the others.

One of the early supplements to milk in infant feeding is cereals. It is apparently not safe to rely upon cereal additions alone to furnish the needed minerals, for the Wisconsin station, again testing the hemoglobin-forming properties of foods on anemic rats, found that certain cereals were not as effective in curing the anemia as was to be expected from their iron content. Cooking the cereals did not improve their potency in preventing or curing anemia, but when a very small amount of pure salt of inorganic iron was added to the ration of milk and cereal, the hemoglobin of the blood increased very rapidly, the anemia was cured, and the animals made excellent growth. Chemical analysis showed that at least one of the cereals used in the experiments contained more iron than has been proved to be necessary for hemoglobin building. Obviously some of it must have been in an unavailable form.

Improving the quality of eggs.—One of the chief problems of poultry raisers is to meet the varying consumer preferences for eggs. Theoretically the demand should be for eggs of the highest nutritive properties, but practically it is often for certain physical qualities, such as color of the shell and of the yolk, as noted on page 48. Fortunately the poultryman is interested in the production of eggs which contain the food essentials required for the development of strong healthy chicks, and these same essentials increase the value of the eggs for human consumption.

Eggs can be enriched in certain constituents through proper feeding of the hens. The Kentucky station found that addition of cod-liver oil to the basal ration of hens increased the copper and iron content of egg yolk (p. 47). It has been found by several of the stations that the vitamin A and D content of eggs can be greatly influenced by the ration fed. Various ingredients of poultry feeds increase both the vitamin A content and the color of egg yolk. The Missouri station found this to be true of yellow corn and alfalfa leaf meal, and the Georgia station of dried pimiento pepper.

Iodine is another constituent of eggs which varies widely. Speaking in general terms of attempts to feed iodine in eggs (p. 47), the Ohio station says:

> Whether eggs of a known iodine content have a particular place in human nutrition probably depends upon whether the iodine requirements of the people of a given locality are provided from other sources. It is common knowledge that the natural foods and drinking water of certain sections are deficient in iodine, and that some form of medication must be resorted to in order to prevent and control endemic goiter. How this can be best accomplished remains an open question. It would seem that medication through the use of natural foods, whose iodine content has been raised by administering the element to the animal, bird, or plant producing them, * * * would in general be less hazardous and more desirable than by other means.

This is the principle behind the attempts cited, and many others at the experiment stations throughout the country, to improve the composition of natural food products so that separate medication with the various essentials for normal nutrition can be avoided as far as possible.

The food habits and requirements of children.—Much more is known about the actual food consumption and dietary requirements of adults than of children, but the development of nursery schools in the last few years has afforded a better opportunity than previously to study the food requirements of children of preschool age. In a study reported by the Michigan station the average daily diet of 20 healthy children between the ages of 30 and 66 months furnished 1,400 calories, 45 grams of protein, and 1 gram each of calcium and phosphorus, representing a little less total food and more protein than is frequently recommended for children of their age. The extra protein was apparently utilized to good advantage.

A study of the protein requirement of preschool children was also made by the Ohio station. The children were from 19 to 36 months of age, a little younger than the Michigan children. Their protein intake was only slightly lower, averaging 38.7 grams daily in one period, 41.2 grams in another. The protein consumption varied considerably from child to child, and also from day to day with the same child, but, taking everything into consideration, it is thought that a protein intake of from 2.48 to 3.3 grams per kilogram of body weight daily "is consistent with good physical development in preschool children." Milk supplied slightly over 50 percent of the total protein, cereals 19, meat and eggs 19, fruit and vegetables 9 percent, and fatty foods the remainder.

Dietary habits and health of farm families.—All of the children in the two studies previously noted were in good health, and hence it may be assumed that they were on satisfactory diets. In a recent study by the New York (Cornell) station of the food habits and health of over 500 farm families in one county of the State, the clearest association between diet and health of the children was found in the case of milk consumption and the quality of the teeth, thus confirming earlier observations from the Massachusetts, Florida, and South Carolina stations. Another striking observation in this study was that the women's teeth deteriorated more rapidly than did the men's, particularly during the childbearing period from 20 to 45 years of age.

> The diets of the women were notably lower in milk and eggs than were the diets of the men, though their need for these foods was as great or greater. A more liberal use of these foods, which were easily available for most of the farm women, might have helped to protect their teeth during the period of childbearing.

Constipation, indigestion, and overweight were all found to be more frequent with the women than with the men, suggesting that perhaps the meals that satisfy the farm operators may not be as suitable for the other members of the family.

Low-cost adequate diets.—As stated in a recent report from the Illinois station, "That long-continued research pays and that the public never knows when the results of such research will be sorely needed is nowhere better proved than in the present emergency requiring the proper feeding of thousands of families at a minimum cost." This emergency has emphasized the importance of such studies of dietary habits and food consumption as have already been reported from various experiment stations and the need for much more work along this line. Meantime the stations are contributing to emergency food relief by publishing information on adequate diets at minimum cost and on the use of farm products and special foods released for relief work. The Hawaii station has published a leaflet on adequate diets at minimum cost for racial groups in Hawaii, and the Illinois station material on low-cost diets for emergency use, ways of using corn as a low-cost food, and directions for using the salted pork distributed by relief agencies.

The selection of household equipment.—With the bewildering array of advertising propaganda and the competition among manufacturers of household equipment, the homemaker is often at a loss to know what specifications are desirable in any piece of equipment, what is the best selection among different types of equipment for the same use, and how any piece of equipment can be used more efficiently. The experiment stations are helping her with many of these problems.

Factors in construction and operation affecting the efficiency of kerosene stoves were studied at the Kansas and Nebraska stations. According to the latter, long-chimney kerosene stoves are much more efficient than short-chimney stoves because of rapidity of heating, complete combustion of the oil, and protection against heat losses.

Electrical equipment is being studied at several of the stations. To cite only a few examples, the Maine station found that the large ovens of high thermal capacity and high preheating cost, such as are to be found in the ordinary electric range, do not meet the daily needs of the ordinary family in the State as well as would small ovens of low thermal capacity. Until such ovens are available the use, where feasible, of small pieces of electric equipment such as electric percolators and toasters is suggested as being more economical of electricity than the range surface and oven. For instance, when brewing coffee an electric percolator consumed approximately 45 percent less electrical energy than the nonelectric percolator on a small open unit. In toasting bread on an electric toaster and in an oven, the toaster consumed only one half as much electric energy as the oven. Contrary to common belief, surface cooking was found more economical than oven cooking when several foods are to be cooked at the same time. The station concludes, therefore, that the oven meal "should be considered an economy only when one of its constituents must necessarily be baked" and that in this case "the added cost of cooking the second and third foods in the oven should be balanced against the cost of cooking them on the surface."

As the result of a study of the relative efficiency of various types of surface units for an electric stove and of utensils of different sizes, shapes, and materials for surface and oven cooking, the Washington station was able to make some very definite suggestions to purchasers of electric stoves and utensils. The most desirable features in surface units are considered to be speed in heating, good heat retention, durability, flatness of upper surface, low cost of operation, and low cost of replacement. Efficient utensils for top stove cooking should have a dull-surfaced flat bottom, highly polished straight sides, and a well fitting cover and should be made of material heavy enough to insure durability with no warping. The diameter of the utensil should be equal to or greater than that of the unit on which it is used. The most efficient oven utensil is one which has an outer surface which readily absorbs or transmits radiant heat, as rough iron, enamel, porcelain or glass, and the least efficient one which has a highly polished surface which reflects radiant heat.

To those faced with the necessity of selecting a new refrigerator, a recent bulletin (239) of the Rhode Island station entitled "Home Refrigeration Methods in Rural Rhode Island" may be recommended for a comparison of the operating costs and efficiency of various types of refrigeration, and for a list of questions which should be answered in determining the choice of an ice or mechanical refrigerator and in making the selection from among the many offered in either type.

The farm contribution to farm-family living.—Studies by a number of stations have shown that the use of home-produced foods by the farm family is increasing. For example, the Maryland station found that about one half of 240 farm homes studied by the station used flour from locally grown wheat. The use of home-produced vegetables appeared to be increasing, but this has had no influence on use of commercial canned goods. Home canning of vegetables and use of fresh and cured meats appeared to be decreasing.

In a study of the food supply of farm families, the Wisconsin station found that nearly half the value of the food consumed was furnished by the farm. Nearly all the milk, cream, eggs, poultry, potatoes, cabbage, fresh tomatoes, and carrots consumed, three fourths of the pork and apples, and two thirds of all meat and fish and onions came from the home farm. On the other hand, only one third of the beef and one sixth of the butter used were produced at home. Cash expenditure was mostly for cereal foods, fats, sugars, food adjuncts, and such fruits as cannot be raised in Wisconsin. The data for bread and flour

indicated that much baking is still done in the farm home. About two fifths of the families reported that they baked all of their bread at home, nearly as many reported that they baked part and bought part, and the remainder did no baking of bread at home. The stage of family development, i.e., in terms of ages of children, appeared to have little relation to the character and amount of home production of food.

Of greater influence in determining whether breads should be baked in the home or purchased, is the size of the family, according to a study by the New York (Cornell) station of the buying habits of a large number of families in the State in 1928–29. Only about one sixth of the small families baked all of their bread, as compared with nearly one half of the large families. In the year in which this study was made farm prices were low and retail prices relatively high. Under such conditions it was estimated that the families who purchased the greater part of their food supply instead of spending labor and time in producing most of the meats, fruits, and vegetables used in their household and in processing enough of these foods for the year's supply, spent four times as much money per capita for food purchases as did those families who processed home-grown foods and bought mainly the staple foods.

If the homemaker is willing to spend time in processing home-grown foods in the home, more of the cash income will be available for purposes other than feeding the family. Whether a homemaker should give this time depends on the alternative opportunities that are available to her.

Cash contributions of the homemaker to the family income.—The Vermont station found that considerable additions were made to the family income by farm women through poultry raising, keeping boarders and overnight guests, handicrafts, sale of garden products, laundering, canning, teaching, writing for newspapers, and conducting roadside stands. Of these diversified occupations poultry raising was the most common method by which the homemakers in this study contributed cash to the family income, and keeping boarders and overnight guests next in importance. In the sale of home products the finding of an adequate market was one of the greatest problems. Another was the standardization of their products.

Purchasing habits of farm families.—The Cornell buying study, already alluded to, revealed the need for more quality standards and grades in foods and other commodities which must be purchased by farm families. Concerning foods the report points out that—

There is much more classification and grading of foods on the wholesale markets than in the retail stores. The consumer knows a little concerning brands, but has practically no information concerning grades unless she asks her retailer for the information. Only if grading of foods becomes universal, and the information is given on the label, will the consumer have an accurate basis for deciding whether price differences are quality differences.

Prices paid for clothing were much more variable than were prices paid for food with even less information available as to quality. In the absence of definite information concerning the quality of the material the consumer has even less to guide her in the selection of clothing than of foods.

These families were not using installment credit to any extent to finance their purchases. "They preferred to buy on cash terms. When they had the cash available, they bought the household articles which they wanted; but when the cash was not available, they preferred to go without the commodities rather than mortgage their future income with a debt contracted by installment buying."

Relation of children to cost of family living.—As the average number of children in farm families rose from 1 to 6 or more, the Wisconsin station found, the annual cost of family living rose from $950 to more than $1,800 per family. If distributed evenly, this increased cost of living would average about $140 per child. Actually, however, the families with 2 and 3 children spent $1,400 annually for family living, while families with 4 and 5 children spent about $1,600.

Different numbers of children per family were found to make varying demands upon the different items of expenditure. House rent and furnishings remained practically constant as the number of children increased from 1 to 6. The costs of household-operation goods, including fuel and light, the family use of the automobile, and amounts spent for health and personal goods and services, increased about 50 percent. The costs for food, and for life and health insurance more than doubled, while the expenditures for clothing and for advancement items practically trebled. The value of goods furnished by the farm for the family living increased less rapidly with increases in the number of children than did the costs in goods and services purchased. The goods fur-

nished averaged about $30 per child as compared with $110 per child for goods and services purchased.

The ages of children were found to be more important than the numbers when standards of living are being considered.

FARM BUSINESS MANAGEMENT AND FINANCE

A considerable and increasingly significant part of the work of the experiment stations is that dealing with such subjects as farm tenancy, farm housing and layout, farm labor and power, farm credit, marketing, and taxation. A few examples of recent station work in these fields are cited below.

Tenancy.—Land proprietorship in the north-central portion of Delaware is considered as nearly comparable to the English system as in any part of the United States. From a study of farm tenancy in the State, the Delaware station found that inheritance and sentiment have been the two most important factors influencing land ownership in the State and have kept land proprietorship concentrated among relatively few. However, a large proportion (50 to 85 percent) of the farms have come under tenant operation. During the past three decades the number of tenant-operated farms as a whole has decreased about one third, the chief forces bringing this about being a continued scarcity of good tenants, a decrease in the part played by inheritance in farm ownership, and a decrease in sentiment in farm ownership. Many weaknesses in the present rental contract were found, but it is considered probably the most workable possible under existing conditions.

Farm housing and layout.—A study by the Maryland station of the character of farmhouses and homes for farm labor showed that some farms failed to get or hold good farmers and good labor because of poor houses. The survey indicated that good farmhouses proved a good investment because they attracted more intelligent labor and maintained better health conditions, which was reflected in both the character and amount of labor done. A study by the station of the layouts or arrangement of 127 farms showed a direct relation between the plan and the labor income. In 1929 the farms with a good layout had an average labor income of $1,753 as compared with $133 for those with a poor layout.

Efficient use of farm power.—Because of the extremely low prices for South Dakota farm products, especially in the wheat-growing area, the problem of whether to use tractors or horses for farm power has become especially important. The South Dakota station has studied the question and has recently reported the results, suggesting a method of deciding on the most economical source of power under varying circumstances. The results of the study show, in general, inefficient use of both tractor and horse power. Many of the farms in the area apparently do not have the best possible power combinations. Increasing the crop acreage of farms would reduce the total cost per acre of the power units thereon and in many cases the increase would make the power units more effective.

If the added acreage could be secured with small cash outlay, the net returns to the farm might be enhanced also. A partial shift from the use of a large tractor to more use of a smaller one, or a shift from tractor as major power to horses as major power, would be desirable on some farms during periods of low prices for farm products. Net returns to the farm business over a period of years should determine any adjustments which would be effective for a long time.

Farm credit.—Operations of agricultural-credit corporations and commercial banks have been studied by the Arkansas station with the result of showing that the agricultural-credit corporations in some instances, where overhead cost had been held to a minimum, supplied farm loans at a lower rate than commercial banks. In other cases the cost, including service charges, were as high as 11 percent. These corporations, however, made credit available to farmers in some localities where no credit could be obtained from commercial banks, and the outlook is for cheaper credit through this source due to the fact that the paper of Federal intermediate credit banks may now be used as security for bank loans from the Federal Reserve System. The station concludes that the cooperative type of local credit corporation as developed in Arkansas would appear to be better adapted to solving the crop-loan problem than is the larger institution organized to extend loans over a considerable territory.

Investigations of farm-mortgage foreclosures and of credit facilities, by the Minnesota station, showed failures and foreclosures to be relatively greater on the poorer land. The station found that loans have been made in the past on the basis of current

land sales in the vicinity rather than on the potential productive power of the farm on which the loan was made. The knowledge gained by the station has been particularly valuable in focusing attention on the necessity for land classification in the State on the basis of utility and productive capacity. It should prove useful in making credit adjustments and in securing new loans. The station also secured information that has proved especially valuable in making debt adjustments between creditor and debtor. The results of the study have been widely distributed and used.

The farm-credit problem has been especially pressing on farmers in South Dakota, and for this reason the station has been putting major emphasis on a study of the subject. The farm-mortgage experiences of life-insurance companies lending in South Dakota have been studied in detail, and a general study of the farm-mortgage situation in the State with special reference to delinquencies and foreclosures has also been undertaken. The results of these studies have been given wide publicity, to serve as a background for concerted action on future credit and land-utilization policies.

Marketing.—Of the 702 cooperatives incorporated under the cooperative laws of New York up to January 1, 1931, the New York (Cornell) station found that about 24 percent were active on that date, 40 percent never had been active after incorporation, and 36 percent had ceased to operate. The station also found, in general, that—

> cooperatives in New York compare favorably in efficiency with private businesses. They have probably suffered less mortality than have private businesses in the same fields. They have made important contributions to the improvement of New York agriculture through savings to their members, by furnishing to their patrons needed services that were not otherwise available, and by reducing the margins of private dealers.

While as a rule the cooperatives have been efficient and soundly financed, the station points out certain particulars in which they may be improved, especially with reference to accounting, auditing, business analysis, and financial planning, including a more general use of a budgeting system.

Faulty grading, packing, and storing of produce, the Florida station finds, are costing Florida growers millions of dollars annually and placing them at a disadvantage in the market. The cause and prevention of this unsatisfactory condition are discussed in some detail in a recent bulletin of the station.

Motor-truck marketing has recently been receiving considerable attention by the stations. The Illinois station has reported a study of cause and prevention of shrinkage in truck and rail marketing of hogs, and the Michigan station studies of motor-truck marketing of livestock and fruits and vegetables. These studies have brought out the relative advantages and disadvantages of motor-truck marketing and have suggested possible improvements of the method.

The Michigan station finds that "livestock farmers in an area served by a cooperative shipping association which ships entirely or principally by rail can generally market their stock at a lower cost as members of such an organization than by shipping individually by truck." The station points out that competition among livestock truckers is keen and that "those who expect to continue operating must estimate their costs more accurately to provide for adequate maintenance and replacement of their equipment as well as in income for their labor."

Among the advantages of truck transportation the station includes the following: "(1) More convenient shipping intervals, (2) the convenience of having the livestock picked up at the farm, and (3) less time in transit." Disadvantages, in addition to greater cost, include: "(1) Reduction in the volume shipped by many associations, (2) a less uniformly reliable transportation agency, (3) the facilitation of direct purchasing by terminal packers insofar as it lowers terminal market prices, and (4) the difficulty of estimating the next day's receipts at the stockyards."

Suggested improvements in rail transportation are: "(1) Lower carlot and l.c.l. rates, (2) more flexible service on l.c.l. shipments, and (3) faster schedules. The changes in truck transportation most desired are: (1) Better enforcement of the State fee on trucks used for hire, (2) lower and more uniform rates, (3) the availability of trucks for pick-up service and short hauls only, and (4) more reliable trucks with better equipment."

For studies relating to marketing of special commodities, see potatoes (p. 22), peaches (p. 29), vegetables (p. 35), cattle (p. 38), turkeys (p. 48), eggs (p. 48), milk (p. 43), cream (p. 43), and ice cream (p. 43).

Taxation.—Taxation continues to be a leading feature of the work of many of the experiment stations, and they have made some noteworthy contributions to the subject, especially in connection with the reform of State and local taxation systems and the use made of tax returns. The Colorado station, for example, has reported studies which have been helpful to the State legislature in formulating a financial program for the State. These studies have shown particularly the need for redistribution and equalization of the tax burden in the interest of rural people, and indicated ways in which this may be done to the benefit of all the people. An analysis by the Connecticut (Storrs) station of the State taxation system proved so enlightening that public sentiment crystallized into the enactment of legislation creating a tax commission on which the station is represented.

Taxation financing education in Delaware is the subject of an exhaustive study of sources and uses of tax funds for educational purposes recently reported by the Delaware station, which shows that the State government of Delaware is supporting liberally its school system and has made rapid progress in improving it. It is stated that in 1930 the State of Delaware spent $5,146,184, representing 48 percent of its budget and 89 percent of all expenditures, for educational purposes.

Unusual interest in farm taxation in Louisiana, with a strong demand for tax revision, led the Louisiana station to make a careful study of the tax system of the State. This showed the weaknesses of the system and yielded basic information to serve as a guide for intelligent action in revising it.

Research by the Maryland station on the farm tax problem showed that Maryland farmers, in common with those in many other sections, carry a relatively heavy tax burden. The amount of taxes levied appeared to be greater than returns from the farm would justify. The study suggested new sources of taxation and ways of shifting and equalizing the burden. As a result of its studies the station recommends a sales tax on luxury commodities and a revision of woodland and inheritance taxes—the former to encourage reforestation, the latter to put a low tax on transfers to near relatives now exempt.

A comprehensive study of farm taxation was completed by the North Carolina station in time for use by the past General Assembly. This work recorded and correlated changes in farm taxation and income. It also related the type of farming to the distribution and amount of delinquent tax returns.

Results of taxation studies recently reported by the Pennsylvania station were of distinct service to State officials as a basis for revision of tax laws. An act of the General Assembly recently signed by the Governor of Pennsylvania relieves, for a 2-year period, all real estate in second-class townships of road taxes except such as are necessary to carry payments on existing indebtedness. This is thought to be the most important step for the relief of rural real estate from excessive taxation ever taken in Pennsylvania. The research of the station was an essential factor in the educational work which made this legislation possible.

Results of considerable social and economic importance are attached to taxation studies recently reported by the South Carolina station. The data furnished by these studies formed the basis for much of the discussion centering around tax reform during the 1933 session of the State legislature. It has been the general opinion that farmers as a group are overtaxed and that property taxes are far from being in proportion to ability to pay. Until publication of data gathered by the station there was, however, insofar as South Carolina is concerned, no concrete evidence and no basis upon which to proceed with proper corrective legislation. There is reason to believe that the findings reported by the station will ultimately bring about a reorganization of the system of taxation, to the advantage of the State and particularly of farmers.

Tax studies by the Texas station have shown that farm lands and city real estate bear a disproportionately high share of the tax burden under the present system of taxation. Real estate, which constitutes 48.6 percent of all property values in the State, bears 70.8 percent of the taxes, while intangible property, which comprises 49 percent of the total, bears but 3.3 percent of the tax burden. Wide inequalities in assessment value were revealed, farms in the same county varying from eightfold to tenfold in relative rates of assessment. A decided tendency to assess large farms and large city properties at a lower rate than small farms and small city properties was found. The published

data from these studies have resulted in attempts to adjust inequalities in assessment values in some counties of the State.

SERVICE

S. W. Johnson, a pioneer in experiment station work in this country and for many years director of the Connecticut Agricultural Experiment Station, said the object of an agricultural experiment station is "to put science at work for agriculture." This is as true now as when Johnson said it, except that the legitimate field of experiment station research has materially broadened since Johnson's day.

There is general agreement that the primary purpose of an experiment station is research—particularly research with a service end in view. An agricultural experiment station, therefore, has little opportunity or disposition to engage in "cloister science." Its business is to bring all the resources of science to the solution of practical problems of agriculture and rural life; to diffuse and aid in applying as well as to acquire useful information.

Speaking of scientific research in general but in a way which seems peculiarly applicable to agricultural research, an English writer says:[2]

> Pure scientific research is not merely the gratification of intellectual curiosity but indeed an essential step in an economic process which results in applications to the practical issues of the day.

In his last annual report (1933), the Secretary of Agriculture makes this significant statement regarding the work of the Department of Agriculture:

> Research is not done in the Department for the sake of its cultural value, or merely to gain knowledge that may or may not be useful. It is rigorously directed to the solution of pressing problems. The research projects are developed in response to keenly felt agricultural and national wants, and pursued to furnish knowledge as a guide to action. It is often necessary to broaden inquiries beyond their original scope so as to reveal basic facts and principles, but this does not mean that the studies lose their utilitarian character. Fundamental research gets results quite as often as hasty attempts to solve problems by short cut methods.

The Secretary's statement applies fully as well, if not more pointedly, to the experiment stations as to the Department.

As a result of years of research and accumulation of accurate information the stations are usually better prepared than any other agency to render certain essential service, such for example as preparation and supervision of the initial use of serums, advising and assisting in the early stages of repression of sudden and serious outbreaks of plant and animal diseases and insect pests, and aiding in the organization and launching of various activities having an important agricultural bearing. Work of this kind which does not weaken research but enhances its practical value renders a useful service which may be legitimately expected of an institution supported with public funds.

With no let-down in the scientific quality of station research, there has developed a keener realization of the fact that fundamental research in agriculture supported by public funds must have a practical and service objective. Under present conditions it is especially important that the stations hold themselves in readiness to give as far as they can whatever public service is demanded of them and to study ways and means of making available the information they now have or may acquire in any way that will aid in improving conditions and advance the national policies having this end in view. Recent developments and present conditions emphasize the importance of this broader view of the service that the stations and their trained specialists can render.

Speaking of the broader objectives of station work, the director of the Connecticut stations says the stations "not only seek the answers to the farmers' problems, insuring eventual control over production and distribution, but they furnish daily, through their highly trained personnel, the technical guidance on which the whole agricultural program depends." Referring to service that the stations may render under present unusual conditions, the director of the Nevada station says: "It seems to me now that the most important thing is that we keep ourselves in a position to give whatever service may be demanded. * * * It will evidently be well worth while to study out actively ways in which the stations may make themselves useful and helpful right now."

Because of their familiarity with local conditions, many of the experiment

[2] ANONYMOUS. COORDINATION IN RESEARCH. Nature [London] 132:77–79. 1933.

stations have been called on to aid in the set-up and administration of the Agricultural Adjustment Act and have realined their work and are maintaining a flexible organization and program to put them in better position to meet these and other emergency calls.

Some specific examples of work recently reported by the experiment stations which represent useful service based on research are as follows:

As a result of its milk-marketing investigations, the Illinois station has been able to assist in settling controversies between milk producers and milk-distributing agencies of some of the large milk markets of the United States and in reducing the costs of producing and marketing milk and milk products. Some idea of the economic value of this work may be gained from the fact that Illinois farmers alone are selling more than $75,000,000 worth of whole milk, butter, and ice-cream materials annually.

Through service on the New England Governors' Dairy Advisory Board, and as milk administrator of the New England Dairies, Inc., the head of dairy work in the Vermont station played an influential part in activities which resulted in increasing the income of New England milk producers nearly or quite $4,000,000 during 1932, and in bringing about an increase in the price of milk to producers, which became effective in May 1933. He was also called into consultation by the governors of the four northern New England States and the Secretary of Agriculture at Washington with regard to the operation of the Federal Farm Relief Act in the interest of the dairymen and consuming public of New England.

Prediction of insect outbreaks has been a useful service to farmers by the Montana station. The station believes that no greater service to the farmers, so far as the control of insects is concerned, can be given than to warn them of coming insect outbreaks. Such information is of enormous importance to growers in lowering cost and increasing efficiency of production. These predictions of insect outbreaks are founded on much of the experimental work going on at the station and in cooperation with the Department. The most valuable advance notices concern grasshoppers and cutworms, but the service is being extended to the beet webworm.

A soil inoculant service has recently been set up by the New York (State) station to keep farmers informed as to developments in the legume-inoculant inspection which the station has recently undertaken and the quality of the inoculants offered for sale.

A volume of similar specific services by the stations might be reported for the year under consideration. In addition, through letter inquiries numbering in the millions annually; through analyses, clinical examinations, and individual conferences numbering in the thousands for each station; and through public programs and the press, the staff members of the stations are daily rendering a volume of services which cannot well be rendered by any other agency, private or public; and in the end the unanswered question and the unsolved technical problem relating to agriculture reaches the research staff of the experiment station, which in effect is the "backlog" of the agricultural agencies.

EXPERIMENT STATIONS IN ALASKA, HAWAII, AND PUERTO RICO

Of the experiment stations in Alaska, Hawaii, Puerto Rico, Guam, and the Virgin Islands, which have been receiving Federal support under the supervision of the Department of Agriculture, those of Alaska passed from the direct jurisdiction of the Department at the beginning of the year and were consolidated as a Territorial station under the Agricultural College and School of Mines at Fairbanks, receiving $15,000 of Federal funds through extension of the Hatch Act to the Territory; the Guam station was closed; and the Virgin Islands station was transferred to the Department of the Interior early in July 1932.

The Hawaii station continued to operate with funds appropriated for the purpose through the Department of Agriculture $40,000, from extension of the Hatch and Adams Acts to Hawaii $24,000, and from other sources $30,500. The relation of this station to the Department has become in a measure the same as that of the State experiment stations.

The status of the Puerto Rico station remained unchanged in all essential respects during the year. An act of Congress of March 4, 1931, provided for the extension to Puerto Rico of the Hatch, Adams, and Purnell Acts

and the Federal extension acts contingent upon coordinating agricultural research and extension activities in the island, but up to the close of the year the terms of the act had not been complied with through satisfactory legislative acceptance of its provisions and the contemplated coordination had not been brought about.

The character of the work of the Hawaii and Puerto Rico stations did not change materially in its major features during the year. The former, as in previous years, gave attention primarily to problems of developing a more diversified and self-sustaining agriculture, leaving those of sugar and pineapple production, the leading industries of the island, to other well-established agencies. The latter continued to give major attention to development and introduction of improved sugarcane varieties, coffee culture, control of animal parasites, and general service in aid of a more self-sustaining agriculture.

CHANGES IN PERSONNEL

Maintenance of an efficient personnel has been one of the most serious problems with which the stations have had to deal during the past year. However, aside from losses through death, 11 having occurred among the leaders in station work during the year, the turnover in the major or key positions was only about 35. Shortage of funds resulted in reduction in salaries and loss of some well-trained, experienced men, and in many shifts especially in the lower grades.

Four changes took place in directorships, as follows: E. P. Sandsten succeeded C. P. Gillette as director of the Colorado station, the change effective September 1, 1932. The former director remained as head of the department of entomology and zoology. J. R. Ricks returned to Mississippi after an absence of 2 years to resume the directorship of the station. W. R. Perkins remained as assistant director. C. E. Ladd, director of extension at the New York State College of Agriculture, was appointed director of the Cornell station, succeeding A. R. Mann. The Virginia Truck station selected as director H. H. Zimmerley of the United States Department of Agriculture, the appointment being effective July 15, 1932.

PUBLICATIONS OF THE STATIONS, 1932–33

The experiment stations are expected to diffuse as well as acquire useful information. Publication is an effective means of diffusing and making useful the results of station work, and is one that is freely used.

The total number of station publications of the regular series received by the Office during the year ended June 30, 1933, was 862, as compared with 845 the previous year. The amount of station funds expended for publications was $278,220 as compared with $336,411 for the previous year.

Classified by scientific subjects, the publications fall into the following groups: Meteorology, 13; soils and fertilizers, 42; field crops, 71; horticulture, 96; forestry, 6; plant diseases, 50; entomology and zoology, 58; foods and human nutrition, 19; rural-home management, 8; animal production, 102; dairying, 50; diseases of livestock, 30; agricultural engineering, 39; economics and sociology, 163; and annual reports and miscellaneous publications, 115. Classified by major general objectives of the work they report, the publications, exclusive of certain purely regulatory and service publications, may be grouped approximately as follows: Improvement in crop production, 350; improvement in animal production and dairying, 200; betterment of the rural home and rural life, 60; and farm-business improvement, 165.

In addition to the regular series of publications, 1,331 articles reporting or based on station work were published in 50 technical and scientific journals, to which should be added 90 articles contributed or collaborated in by 30 stations published in the Journal of Agricultural Research.

The nature of station publications shows no material change except a possible trend toward putting greater emphasis on the significance of the results of research from the economic, social, and practical standpoints. They constitute a great storehouse from which teachers and extension workers as well as investigators and the general public can draw reliable information relating to almost every phase of agriculture and rural life, as well as many questions affecting the well-being of urban people.

INCOME, EXPENDITURES, AND OTHER STATISTICS, 1933

By J. I. Schulte

The following tables give detailed data regarding: (1) Personnel, publications, and mailing lists of the experiment stations; (2) revenues and additions to equipment; (3) expenditures from the Hatch, Adams, and Purnell funds; (4) expenditures from the supplementary funds; and (5) total disbursements from the United States Treasury under the Hatch, Adams, and Purnell Acts from their passage to the end of the fiscal year, June 30, 1933.

Table 5.—*Personnel, publications, and mailing lists of the experiment stations, 1933*

Station	Date of original organization	Date of organization under Hatch Act	Persons on staff	Teachers on staff	Persons on staff assisting in extension work	Publications during fiscal year		Names on mailing list
						Number	Pages	
Alabama	February 1883	Feb. 24, 1888	57	24		5	180	3,300
Alaska	—— 1898		2	1		1	40	1,357
Arizona		—— 1889	48	25		14	775	5,887
Arkansas		—— 1887	49	29		16	632	5,500
California	—— 1875	March 1888	215	124	140	35	1,599	11,050
Colorado		Feb. 29, 1888	72	46	9	21	864	800
Connecticut (State)	Oct. 1, 1875	May 18, 1887	45			20	900	16,600
Connecticut (Storrs)		do	31	9	7	1	250	10,500
Delaware		Feb. 21, 1888	24	6	3	8	655	8,000
Florida		—— 1888	20	2	2	25	1,054	12,000
Georgia	Feb. 18, 1888	July 1, 1889	30			25	199	7,000
Hawaii	—— 1901		15	8	1	5	160	2,666
Idaho		Feb. 26, 1892	54	26	6	12	396	14,960
Illinois		Mar. 21, 1888	121	77	15	63	2,316	20,000
Indiana	—— 1885	January 1888	108	24		58	1,090	38,680
Iowa		Feb. 17, 1888	126	85	13	44	1,456	16,973
Kansas		Feb. 8, 1888	116	81		17	701	12,000
Kentucky	September 1885	April 1888	76	26	5	14	540	12,000
Louisiana	April 1886		51	7	3	11	372	4,780
Maine	March 1885	Oct. 1, 1887	38	4		8	454	17,000
Maryland	—— 1888	April 1888	69	26	8	15	440	22,000
Massachusetts	—— 1882	Mar. 2, 1888	78	12	8	53	753	16,600
Michigan		Feb. 26, 1888	126	74	5	38	1,545	15,000
Minnesota	Mar. 7, 1885	—— 1888	176		7	150	1,215	13,000
Mississippi		Jan. 27, 1888	51	14		4	249	15,000
Missouri		January 1888	86	60	1	54	622	4,986
Montana		July 1, 1893	48	11	6	18	722	5,000
Nebraska	Dec. 16, 1884	June 13, 1887	55	15		20	614	12,000
Nevada		December 1887	18	1		4	71	5,000
New Hampshire	—— 1886	Aug. 4, 1887	51	22	6	19	390	8,000
New Jersey (College)		Apr. 26, 1888	39					
New Jersey (State)	Mar. 10, 1880		[1] 84	51	30	45	626	12,000
New Mexico		Dec. 14, 1889	28	13	5	85	583	10,000
New York (Cornell)	—— 1879	April 1888	149	86	3	43	2,578	1,647
New York (State)	March 1882		72			62	1,246	12,000
North Carolina	Mar. 12, 1877	Mar. 7, 1887	49	11	2	24	510	18,360
North Dakota		March 1890	56	11	3	13	510	9,200
Ohio	Apr. 25, 1882	Apr. 2, 1888	132	25	4	106	2,036	44,620
Oklahoma		Oct. 27, 1890	66	43		15	1,006	6,346
Oregon		July 1888	103	34		15	450	1,800
Pennsylvania		June 30, 1887	120	92		16	388	31,942
Puerto Rico	—— 1901		5			6	44	1,537
Rhode Island		July 30, 1888	23	4	2	11	247	2,200
South Carolina		January 1888	52	12	1	10	483	6,000
South Dakota		Mar. 13, 1887	32	31	2	18	107	3,500
Tennessee	June 8, 1887	Aug. 4, 1887	38	5	0	22	142	13,603
Texas		Apr. 3, 1889	127			94	1,995	77,001
Utah		—— 1890	45	25	6	20	416	10,000
Vermont	Nov. 24, 1886	Feb. 28, 1888	26	11	1	16	790	3,575
Virginia	—— 1888	—— 1891	52	15	7	8	392	12,000
Washington		—— 1891	56	24		20	773	27,347
West Virginia		June 11, 1888	50	26	3	9	220	12,000
Wisconsin	—— 1883	—— 1887	142	81	57	8	453	51,207
Wyoming		Mar. 1, 1891	36	18	2	8	272	8,000
Total			3,620	1,457	373	1,452	37,521	713,524

[1] Including 18 who are on college staff but not included in total.

TABLE 6.—*Revenues and expenditures*

Station	Revenues						
	Federal			State	Balance from previous year [1]	Fees	Sales
	Hatch fund	Adams fund	Purnell fund				
Alabama	$15,000	$15,000	$60,000	$94,578.18	$169,887.38		$10,845.38
Alaska	15,000						1,167.70
Arizona	15,000	15,000	60,000	90,610.55	216.94		3,703.19
Arkansas	15,000	15,000	60,000	77,940.44			15,345.43
California	15,000	15,000	60,000	999,814.86	17,265.35		39,374.13
Colorado	15,000	15,000	60,000	84,787.57	27,212.75		18,204.28
Connecticut (State)	7,500	7,500	30,000	240,013.20	11,302.74	$21,000.00	
Connecticut (Storrs)	7,500	7,500	30,000	43,000.00	4,353.89	3,059.45	1,634.77
Delaware	15,000	15,000	60,000	17,684.65	2,807.98		10,271.27
Florida	15,000	15,000	60,000	330,145.61	16,020.55		12,488.67
Georgia	15,000	15,000	60,000	17,259.06	9,547.06		15,752.36
Hawaii [2] [4]	15,000	9,000		12,997.83	189.66		15,858.16
Idaho	15,000	15,000	60,000	30,063.41	3,597.65		2,003.82
Illinois [3]	15,000	15,000	60,000	321,950.22			50,480.05
Indiana	15,000	15,000	60,000	275,455.69	126,569.34	85,960.38	36,776.03
Iowa	15,000	15,000	60,000	248,245.25	15,223.48		30,950.33
Kansas	15,000	15,000	60,000	84,434.41	43,832.19	41,391.45	
Kentucky	15,000	15,000	60,000	96,475.65	4,891.57	89,068.46	31,034.45
Louisiana	15,000	15,000	60,000	92,670.00	2,198.99	20,538.80	11,245.47
Maine	15,000	15,000	60,000	46,086.13		13,710.49	8,814.55
Maryland	15,000	15,000	60,000	86,249.83	2,931.60		17,525.57
Massachusetts	15,000	15,000	60,000	162,208.39		64,285.66	6,089.14
Michigan	15,000	15,000	60,000	274,658.45			22,504.70
Minnesota	15,000	15,000	60,000	328,991.25		134.73	52,747.01
Mississippi	15,000	15,000	60,000	69,992.48			18,173.96
Missouri	15,000	15,000	60,000	30,886.56	26,249.81	8,375.97	30,642.50
Montana	15,000	15,000	60,000	105,235.98	6,697.98		14,351.37
Nebraska	15,000	15,000	60,000	141,919.38	3,017.13		36,088.02
Nevada	15,000	15,000	60,000	1,060.14	3,368.19		3,636.18
New Hampshire	15,000	15,000	60,000	4,181.63	10,506.73		1,347.20
New Jersey (College)	15,000	15,000	60,000				
New Jersey (State)				372,266.66		45,829.29	66,720.37
New Mexico	15,000	15,000	60,000	5,625.00	31,595.48		10,961.96
New York (Cornell)	13,500	13,500	54,000	993,926.78			52,789.00
New York (State)	1,500	1,500	6,000	422,578.99	7,505.06		9,197.91
North Carolina	15,000	15,000	60,000	65,803.40	228.21		25,165.45
North Dakota	15,000	15,000	60,000	479.66	145,433.62		48,850.42
Ohio	15,000	15,000	60,000	135,501.59	454,345.72		48,981.68
Oklahoma	15,000	15,000	60,000	103,067.08	12,007.70		19,767.07
Oregon	15,000	15,000	60,000	94,492.49	53,314.99		37,262.17
Pennsylvania	15,000	15,000	60,000	103,511.31	2,060.91		28,812.09
Puerto Rico [2] [4]							
Rhode Island	15,000	15,000	60,000		124.06		6,470.84
South Carolina	15,000	15,000	60,000	47,600.00	3,846.88		44,864.57
South Dakota	15,000	15,000	60,000	27,969.75	7,591.81		7,661.33
Tennessee	15,000	15,000	60,000	19,275.80	490.59		9,308.82
Texas	15,000	15,000	60,000	334,066.00	54,892.48		80,765.52
Utah	15,000	15,000	60,000	65,163.16			8,902.63
Vermont	15,000	15,000	60,000		345.19	21,061.26	1,212.68
Virginia	15,000	15,000	60,000	79,477.14			7,188.79
Washington	15,000	15,000	60,000	92,259.72			24,683.86
West Virginia	15,000	15,000	60,000	57,592.00	51.57		28,837.13
Wisconsin	15,000	15,000	60,000	261,877.66			44,550.57
Wyomihg	15,000	15,000	60,000	48,116.57	17,191.63		19,241.37
Total	750,000	729,000	2,880,000	7,740,247.56	1,298,914.86	414,415.94	1,151,251.92

[1] Not including balances from Federal funds.
[2] Support from direct appropriations to the U.S. Department of Agriculture given under "Miscellaneous", Hawaii $40,000.
[3] Including unexpended balance, Hatch $16.74 and Purnell $68.09.
[4] Impounded by provision of the acts of June 30, 1932, and Mar. 20, 1933; Hawaii $2,717, Puerto Rico, $19,619.

for additions to equipment, 1933

Revenues—Continued		Additions to equipment						
Miscellaneous	Total	Buildings	Library	Apparatus	Farm implements	Livestock	Miscellaneous	Total
----------	$365,310.94	$308.28	$718.20	$1,326.77	$210.23	$92.75	$738.11	$3,394.34
----------	16,167.70	659.49	17.25	----------	----------	----------	----------	676.74
----------	184,530.68	1,427.77	----------	2,718.35	2,664.18	366.00	----------	7,176.30
$850.00	184,135.87	4,854.75	1,186.28	5,150.32	2,520.91	1,112.12	723.57	15,547.95
53,632.54	1,200,086.88	64,925.24	10,000.00	8,884.72	15,923.21	10,675.48	----------	110,408.65
680.00	220,884.60	2,997.38	748.29	3,652.82	3,156.79	48.00	672.09	11,275.37
5,000.00	322,315.94	65,000.00	2,286.85	609.07	3,969.51	----------	9,952.53	81,817.96
----------	97,048.11	359.23	983.24	678.90	----------	----------	222.85	2,244.22
----------	120,763.90	1,874.19	850.33	1,745.24	1,422.35	----------	----------	5,892.11
----------	448,654.83	14,108.39	2,131.34	2,714.79	9,750.15	2,551.21	1,396.30	32,652.18
----------	132,558.48	----------	1,047.99	1,133.55	1,099.51	1,000.00	1,917.56	6,198.61
40,026.27	93,071.92	482.40	215.60	832.80	346.22	329.62	1,238.41	3,445.05
----------	125,664.88	9,535.00	50.00	1,290.00	197.00	700.00	380.00	12,152.00
8,479.76	470,910.03	255.41	----------	----------	----------	10,334.38	----------	10,589.79
77,050.18	691,811.62	15,955.52	2,470.33	6,596.97	2,512.65	525.45	3,469.12	31,530.04
----------	384,419.06	----------	----------	8,054.29	2,608.86	6,980.09	556.94	18,200.18
5,590.00	265,248.05	20,089.58	138.23	1,127.70	9,891.74	3,000.53	606.06	34,853.84
----------	311,470.13	----------	136.49	1,240.43	530.90	1,097.23	1,492.18	4,497.23
2,318.68	218,971.94	3,364.21	54.62	485.74	1,812.58	984.29	2,965.57	9,667.01
----------	158,611.17	20,539.13	1,278.11	2,695.01	774.56	161.95	1,406.87	26,855.63
29,656.81	226,363.81	2,131.16	528.19	4,568.90	4,505.52	1,184.96	1,525.58	14,444.31
7,717.82	330,301.01	665.00	705.00	1,779.00	1,975.00	281.00	1,011.00	6,416.00
----------	387,163.15	1,025.00	1,186.00	2,693.00	333.00	111.00	2,540.00	7,888.00
5,450.00	477,322.99	6,198.87	1,635.20	16,266.52	7,525.05	19,842.92	3,844.29	55,312.85
2,028.41	180,194.85	----------	115.83	839.34	----------	----------	----------	955.17
20,004.88	206,159.72	3,407.46	205.95	4,538.06	2,939.04	4,967.67	457.47	16,515.65
----------	216,285.33	5,500.00	891.00	1,770.00	3,500.00	500.00	250.00	12,411.00
----------	271,024.53	12,714.92	214.91	3,098.00	1,511.26	12,224.96	68,632.10	98,396.15
----------	98,064.51	639.97	166.90	1,350.13	179.11	979.25	400.50	3,715.86
28,659.53	134,695.09	557.31	602.88	2,713.97	1,404.52	178.15	937.66	6,394.49
----------	90,000.00	----------	----------	----------	----------	----------	----------	----------
23,227.63	508,043.95	----------	671.77	8,669.54	984.01	335.00	----------	10,660.32
----------	138,182.44	534.98	42.50	1,036.40	2,165.82	470.50	1,053.46	5,303.66
9,547.61	1,137,263.39	398,312.63	2,922.10	62,710.08	12,194.85	344.83	8,320.49	484,804.98
----------	448,281.96	----------	3,186.25	5,389.46	2,156.30	----------	62,917.11	73,649.12
12,664.90	193,861.96	12,087.12	499.83	1,253.09	1,653.42	611.02	----------	16,104.48
----------	284,763.70	7,404.88	782.03	721.02	4,665.09	5,525.52	----------	19,098.54
12,802.42	741,631.41	24,628.24	804.77	242.88	1,750.08	7,210.06	48.18	34,684.21
39,960.25	264,802.10	1,600.40	922.38	2,889.14	1,189.66	1,716.23	7,323.29	15,641.10
16,763.55	291,833.20	1,824.53	97.26	2,083.79	3,615.30	6,529.00	2,206.55	16,356.43
----------	224,384.31	----------	262.28	166.86	276.75	----------	333.45	1,039.34
63,560.00	63,560.00	----------	77.01	78.24	50.10	----------	273.78	479.13
1,007.74	97,602.64	3,700.00	340.00	725.00	1,100.00	41.00	1,200.00	7,106.00
----------	186,311.45	1,634.69	881.00	3,666.59	2,586.22	1,661.50	532.80	10,962.80
1,842.89	135,065.78	200.00	250.00	1,530.00	200.00	----------	----------	2,180.00
----------	119,075.21	----------	845.18	3,069.77	1,081.31	----------	803.49	5,799.75
73,877.67	633,601.67	5,301.10	1,147.56	2,836.19	6,285.61	6,849.82	3,048.15	25,468.43
500.00	164,565.79	615.34	400.00	2,943.49	353.50	2,052.68	844.50	7,209.51
----------	112,619.13	3,325.67	348.52	1,000.78	2,306.75	164.50	----------	7,146.22
----------	176,665.93	144.09	550.00	963.50	178.63	----------	180.47	2,016.69
3,701.53	210,645.11	7,503.55	2,451.75	3,903.25	1,029.95	3,251.88	888.69	19,029.07
500.00	176,980.70	5,550.85	25.49	2,852.36	3,557.11	6,800.77	----------	18,786.58
65,701.63	462,129.86	620.10	1,437.40	3,727.77	985.25	1,276.31	1,227.42	9,274.25
----------	174,549.57	4,394.50	300.00	1,106.45	685.87	1,125.18	390.15	8,002.15
612,802.70	15,576,632.98	738,958.33	49,810.09	204,120.04	134,315.43	126,194.81	198,928.74	1,452,327.44

TABLE 7.—*Expenditures from United States appropriations received under*

Station	Amount of appropriation	Classified expenditures						
		Salaries	Labor	Publications	Postage and stationery	Freight and express	Heat, light, water, and power	Chemical supplies
Alabama	$15,000	$11,398.25	$1,836.78	4.25	$131.00	$92.64	$20.19	$81.77
Alaska	15,000	8,103.39	2,599.70	6.05	200.95	334.11	1,046.29	27.45
Arizona	15,000	14,536.40	1.76	461.84				
Arkansas	15,000	8,585.15	2,648.57	1,543.50	114.86	76.12	189.27	180.67
California	15,009	15,000.00						
Colorado	15,000	15,000.00						
Connecticut (State)	7,500	7,500.00						
Connecticut (Storrs)	7,500	7,500.00						
Delaware	15,000	8,518.00	1,853.45	1,251.79	1,367.54	28.38	224.67	151.49
Florida	15,000	15,000.00						
Georgia	15,000	8,247.50	2,272.61	311.45	659.31	287.18	508.35	17.01
Hawaii	15,000	8,892.00	2,463.56	80.00	89.48	78.25		509.81
Idaho	15,000	9,572.36	2,173.64	319.66	380.09	75.07	12.85	1,044.28
Illinois	15,000	14,282.52	637.50					
Indiana	15,000	15,000.00						
Iowa	15,000	13,389.53	817.39	202.29	39.22	2.14	45.00	50.35
Kansas	15,000	9,700.00	4,570.13	75.96	73.24	1.68		118.33
Kentucky	15,000	14,619.25		326.84				
Louisiana	15,000	7,475.00	4,087.49	1,458.10	498.32	33.28	66.35	27.54
Maine	15,000	8,945.50	2,544.39	9.00	349.72	24.98	1,179.54	22.14
Maryland	15,000	13,645.01	1,335.00		19.99			
Massachusetts	15,000	14,845.95						
Michigan	15,000	15,000.00						
Minnesota	15,000	15,000.00						
Mississippi	15,000	11,186.66	1,166.19		488.60	111.51	388.79	172.21
Missouri	15,000	10,432.71	1,712.43	110.09	258.59	224.73	44.83	216.62
Montana	15,000	9,651.41	1,646.33	58.64	85.96	6.61	34.70	236.08
Nebraska	15,000	15,000.00						
Nevada	15,000	8,741.19	2,528.12	20.25	662.78	1.25	216.43	
New Hampshire	15,000	9,698.03	757.53	717.40	1,107.28	319.70	700.73	20.25
New Jersey	15,000	10,583.72	872.27	177.70	311.91		40.37	189.91
New Mexico	15,000	8,376.97	3,375.17	1,553.29	263.44	140.64	405.14	121.59
New York (Cornell)	13,500	8,684.05	2,811.45		145.61	7.63	.35	1,103.45
New York (State)	1,500	1,475.03						
North Carolina	15,000	13,080.00	243.58		232.73	31.83	4.14	207.65
North Dakota	15,000	15,000.00						
Ohio	15,000	11,705.38		284.48	1.18		1,122.12	97.10
Oklahoma	15,000	4,442.51	6,121.52	171.90	3.63	18.76	31.39	649.96
Oregon	15,000	9,545.15	3,232.56	519.57	88.75	30.67	209.13	14.89
Pennsylvania	15,000	13,534.85	607.60	752.31		20.33		
Rhode Island	15,000	6,985.57	3,968.06	475.04	423.19	105.72	305.82	158.44
South Carolina	15,000	8,104.92	2,729.83	356.14	557.84	167.57	53.55	206.18
South Dakota	15,000	9,332.99	1,682.93	1,465.83	682.12	54.79	16.50	222.26
Tennessee	15,000	10,674.00	2,060.89	264.67	444.56	55.49	26.13	52.24
Texas	15,000	15,000.00						
Utah	15,000	8,699.52	3,462.57	71.44	85.05	26.58		137.29
Vermont	15,000	9,752.91	884.01	1,652.92	330.48	19.60	641.42	135.19
Virginia	15,000	7,975.20	2,750.14	1,058.03	141.90	90.59	504.11	236.47
Washington	15,000	11,065.18	1,295.73	1,949.76	3.56	22.14		87.92
West Virginia	15,000	7,170.00	3,805.60		33.78	121.40	148.35	499.40
Wisconsin	15,000	13,859.50	1,047.75					92.75
Wyoming	15,000	8,324.24	4,121.66	182.30	456.43	64.43	180.15	97.76
Total	750,000	557,837.50	82,725.89	17,892.49	10,733.09	2,675.80	8,366.66	7,186.45

the act of Mar. 2, 1887 (Hatch Act), for the year ended June 30, 1933

Classified expenditures—Continued

Seeds, plants, and sundry supplies	Fertilizers	Feeding stuffs	Library	Tools, implements, and machinery	Furniture and fixtures	Scientific apparatus	Livestock	Travel expenses	Contingent expenses	Buildings and land	Balance
$153.76	$21.75	$525.18	$404.81	$97.05		$51.54		$150.15	$26.00	$4.88	
153.33		1,247.74	17.25	402.19	$2.75			143.75	55.56	659.49	
582.43	287.10	166.70		381.94			$24.20	204.49	15.00		
289.65	121.02		661.81	130.15	206.52	89.50		93.29	5.00	7.74	
684.55	361.14	219.80	38.42	797.27	61.44	3.60	20.00	308.81		201.56	
377.62	27.25	1,353.68		132.30		255.91	175.00	402.61	81.70		$80.83
119.93	7.00	71.85		452.30	44.85	186.20		529.69	2.55	7.68	
											79.98
114.15	.55	196.01		39.89	7.50	42.98		49.25	3.75		
61.12			14.90	68.77		11.15		304.72			
								53.91			
110.87	203.54	2.10		342.51	96.48	74.75		463.18	39.99	20.50	
182.25		124.28	571.46	111.47	14.88	87.23		788.40	11.33	33.43	
								154.05			
376.55		86.50	15.00	528.51	34.09		3.50	266.14	28.60	147.15	
258.10	73.00	912.34	38.66	406.63	7.64	32.96		227.49	5.58	37.60	
437.11		401.94	281.71	89.00	1,344.52	385.76		333.74	6.49		
539.75		1,364.21		84.20	70.90		126.00	342.26	103.50	199.16	
183.96	121.75		469.54	54.68	90.15	265.61		455.01	38.38		
275.49	17.88	360.00	256.54	117.33	171.34	182.23	300.00	1,081.89	61.42		
330.46	35.00		1.50	317.03	16.15	33.62	30.00				
233.66				261.66		252.14					
						24.97					
124.98	12.56		113.50		91.83			716.55		140.65	
43.37		878.43		838.08	29.86						
956.28	7.45	660.26	9.00	562.24	127.80	243.82	407.70	517.98		67.80	
201.39	120.68			146.39	41.00			646.75	26.10	176.97	
14.00	70.91										
565.24	79.60	59.10	334.57	690.61	114.75	25.42		140.17	12.00	556.70	
562.42	268.01	266.00	706.68	298.99	61.15			401.75		258.97	
213.76	9.40	735.18		122.30	54.20	31.32		168.92		207.50	
147.82	20.58		428.71	175.19	10.35	4.57		127.17	9.72	497.91	
661.92		825.72	57.80	44.81	244.62	8.05		644.73		29.90	
234.04	16.65		226.20	69.51	33.74			408.91	189.45	404.97	
231.76	84.89	1,140.20	16.10	126.32	35.68	392.71		112.96		102.94	
59.73				12.45		10.09		493.44			
217.13	21.00	779.34	16.42	1,366.15		415.15	150.00	229.25	7.03	20.00	
703.58			7.70	490.79	65.53		16.00	173.27	47.08	69.08	
10,402.16	1,988.71	12,376.56	4,688.28	9,758.71	3,079.72	3,111.28	1,252.40	11,134.68	776.23	3,852.58	160.81

TABLE 8.—*Expenditures from United States appropriations received under*

Station	Amount of appropriation	Classified expenditures						
		Salaries	Labor	Postage and stationery	Freight and express	Heat, light, water, and power	Chemical supplies	Seeds, plants, and sundry supplies
Alabama	$15,000	$11,329.76	$975.93	$61.51	$51.18	$54.87	$1,121.12	$123.47
Arizona	15,000	10,600.08	1,876.58	19.52	20.06		436.47	276.58
Arkansas	15,000	9,260.00	1,936.19	78.59	83.87		1,471.83	628.01
California	15,000	15,000.00						
Colorado	15,000	15,000.00						
Connecticut (State)	7,500	7,500.00						
Connecticut (Storrs)	7,500	7,500.00						
Delaware	15,000	11,468.44	1,216.98	46.03	15.69	2.75	1,054.19	86.18
Florida	15,000	15,000.00						
Georgia	15,000	11,546.00	1,556.81	16.92	6.74	472.76	359.51	35.06
Hawaii	9,000	7,302.00	752.35		6.82		351.62	2.54
Idaho	15,000	13,368.82	730.45	7.26	8.83		312.62	95.11
Illinois	15,000	7,067.63	7,875.66					
Indiana	15,000	12,451.90	814.88	4.28	10.15		456.31	50.84
Iowa	15,000	9,652.60	2,668.32	64.57	139.61	81.45	570.71	1,009.59
Kansas	15,000	10,300.00	3,609.46	19.64	3.00		160.69	17.47
Kentucky	15,000	14,798.62	3.20		.49	22.90	40.35	
Louisiana	15,000	11,863.33	1,328.05	21.58	59.59	33.30	699.40	63.39
Maine	15,000	15,000.00						
Maryland	15,000	14,956.61		.09				
Massachusetts	15,000	15,000.00						
Michigan	15,000	15,000.00						
Minnesota	15,000	15,000.00						
Mississippi	15,000	11,126.62	2,507.00	1.59	20.01	411.97	189.64	222.91
Missouri	15,000	3,817.38	4,398.14	28.95	237.73	101.54	2,128.20	419.67
Montana	15,000	11,425.48	1,759.88	16.34	9.35	11.93	382.74	267.25
Nebraska	15,000	15,000.00						
Nevada	15,000	9,198.15	3,474.78	47.86	29.06		590.16	140.01
New Hampshire	15,000	12,700.06	625.72	7.50	33.03		370.28	106.43
New Jersey	15,000	10,231.00	441.33	40.12		612.93	1,163.50	171.21
New Mexico	15,000	9,265.62	2,780.13	34.23	120.50	342.51	653.83	354.48
New York (Cornell)	13,500	11,982.69	762.85	61.03	.98		326.07	97.37
New York (State)	1,500	1,500.00						
North Carolina	15,000	12,680.00	316.98	5.11	48.48	88.32	767.29	141.23
North Dakota	15,000	15,000.00						
Ohio	15,000	10,433.42	3,888.85	2.46			176.93	91.18
Oklahoma	15,000	8,078.97	2,748.90	7.57	10.57	9.00	1,302.42	313.49
Oregon	15,000	11,720.51	1,844.52	17.32	40.77	157.58	529.73	159.73
Pennsylvania	15,000	14,800.00	180.90				19.10	
Rhode Island	15,000	11,569.68	2,262.71	14.10	8.65	231.35	48.59	165.86
South Carolina	15,000	12,415.80	462.70	123.12	40.82	205.62	231.45	177.07
South Dakota	15,000	8,921.81	2,758.88	117.03	95.82	.60	494.77	329.59
Tennessee	15,000	11,788.00	368.28	10.50	113.47	41.70	344.63	23.22
Texas	15,000	14,700.00	70.00	.20	4.50		88.45	
Utah	15,000	9,160.44	3,584.88	55.56	20.76	475.00	770.72	265.97
Vermont	15,000	11,400.67	2,210.75	34.33	24.26	61.12	442.89	177.47
Virginia	15,000	11,935.50	2,808.75	3.66	1.00		74.03	35.40
Washington	15,000	12,663.29	1,294.35	11.58			490.00	52.10
West Virginia	15,000	10,959.98	2,197.68	16.95		96.21	654.06	74.84
Wisconsin	15,000	12,882.40	2,117.60					
Wyoming	15,000	12,152.91	682.45	2.40	286.43		744.92	197.82
Total	729,000	585,476.17	71,893.87	999.50	1,552.22	3,515.41	20,019.22	6,372.54

the act of Mar. 16, 1906 (Adams Act), for the year ended June 30, 1933

Classified expenditures—Continued

Fertilizers	Feeding stuffs	Library	Tools, implements, and machinery	Furniture and fixtures	Scientific apparatus	Livestock	Travel expenses	Contingent expenses	Buildings and land	Balance
	$1.09		$517.84	$18.71	$676.32		$52.90		$15.30	
$30.95		$8.80	66.88	339.60	231.49		1,063.19	$26.55	3.25	
102.28	141.22	100.73	89.61	10.00	825.47		264.70		7.50	
		2.50	8.56	61.67	861.49		174.32	1.20		
	431.60	9.00	65.90		342.28		116.17		41.25	
		2.50	22.50		559.67					
	88.98		23.40		189.92		169.66	4.95		
										$56.71
	212.10		36.77		913.07	$49.70				
4.50	552.41		110.93	27.24	74.34		43.48	.25		
	491.01		54.23	20.00	158.40	47.00	119.10			
	4.00	5.44				125.00				
	480.65	5.00	29.10		224.85	56.00	48.68		87.08	
							43.30			
285.20			207.03			1.00	.78	26.25		
11.00	2,063.86		258.72		867.40	91.90	17.33		558.18	
	7.50	17.58	92.13	28.76	372.83	39.00	566.96	2.27		
	861.76		40.96	37.55	133.22	106.50	249.99		90.00	
	229.65		9.35	39.04	445.46		38.61	2.14	392.73	
		307.60	15.00	291.45	931.40		11.00	39.72	743.74	
143.90			436.59	2.30	363.83		323.15		178.93	
143.90			6.89		118.22					
43.66	31.53	101.50	58.23	6.48	358.23		352.96			
	370.76					36.40				
	1,168.37	4.43	303.49		592.71	42.18	164.08		253.82	
70.20			148.35		180.63		125.91	4.75		
39.00	479.55	5.00	68.25		13.22	14.40	1.44		78.20	
			414.56	9.30	662.10		257.46			
36.39	143.10	174.04	363.66	624.57	166.85		772.89			
1.70		48.23	168.87	395.10	1,506.38		121.29		68.63	
	136.85									
		5.00	69.47	324.60	41.12		50.81		175.67	
25.90		22.21	60.23	67.35	282.49	12.50	172.83	5.00		
			3.00		128.92		9.74			
3.75		12.19	21.25	1.65	39.55		410.29			
23.80	38.25		57.53		840.82	5.60	15.65			18.63
	132.85		122.49	3.00	45.00	202.80	426.93			
966.13	8,067.09	831.75	3,951.77	2,308.37	13,147.68	829.98	6,185.60	113.08	2,694.28	75.34

TABLE 9.—*Expenditures from United States appropriations received under*

Station	Amount of appropriation	Classified expenditures							
		Salaries	Labor	Publications	Postage and stationery	Freight and express	Heat, light, water, and power	Chemical supplies	Seeds, plants, and sundry supplies
Alabama	$60,000	$44,959.43	$7,153.66	$367.99	$195.52	$720.34	$489.89	$695.25	$1,047.49
Arizona	60,000	42,378.72	5,123.34	936.29	48.83	250.72	86.42	2,592.41	521.93
Arkansas	60,000	45,426.16	3,671.97	3,960.40	510.23	128.99	271.51	1,272.48	264.93
California	60,000	57,627.80	2,372.20						
Colorado	60,000	43,166.26	6,783.21	1,328.04	255.60	205.20	15.70	1,521.45	314.52
Conn. (State)	30,000	20,828.85	4,652.29		95.42	39.07	63.34	938.98	215.69
Conn. (Storrs)	30,000	24,497.16	1,763.82	17.50	599.52	13.67		74.62	
Delaware	60,000	39,494.50	6,591.01	2,404.14	98.65	80.97	808.16	520.71	473.16
Florida	60,000	40,471.35	10,209.94	559.30	170.62	57.34	35.25	2,117.70	754.58
Georgia	60,000	39,398.82	6,755.33	422.41	413.99	709.09	1,861.17	994.78	568.64
Idaho	60,000	40,988.14	6,274.57	1,641.73	410.15	173.19	325.92	1,602.72	333.14
Illinois	60,000	35,487.25	8,008.60	2,781.24	842.14	75.61		348.81	1,046.72
Indiana	60,000	42,172.98	3,662.69	774.92	468.42	104.46	24.00	346.02	363.14
Iowa	60,000	35,539.36	11,573.10	240.20	587.25	184.60	685.55	1,626.01	2,511.97
Kansas	60,000	30,000.00	23,324.05	165.19	33.34	34.07	1.25	1,574.45	361.30
Kentucky	60,000	54,891.28	1,689.23	985.49	86.50	20.35	69.09	402.83	82.24
Louisiana	60,000	42,449.96	9,157.98	242.79	391.45	288.01	406.76	556.47	414.66
Maine	60,000	43,020.85	4,114.27	9.00	267.91	140.85	879.24	321.13	1,037.26
Maryland	60,000	50,942.85	2,701.05	1,307.28	188.83	44.48	44.36	720.18	185.77
Massachusetts	60,000	50,452.00	3,990.32	835.83	210.62	13.20	3.00	313.97	497.84
Michigan	60,000	45,709.72	5,360.14	4,223.78	235.30	3.86		587.98	184.94
Minnesota	60,000	54,433.48	759.20	821.38	5.40	34.90	11.00	754.81	329.53
Mississippi	60,000	39,976.38	8,155.22	157.02	355.93	805.38	867.10	1,217.48	798.33
Missouri	60,000	20,006.06	15,442.25	3,864.16	443.76	479.88	128.87	2,710.06	918.44
Montana	60,000	39,504.07	10,111.96	663.53	238.90	174.75	78.50	706.26	1,118.35
Nebraska	60,000	38,310.57	8,890.79	1,008.17	241.80	72.29	15.79	1,094.65	398.50
Nevada	60,000	31,278.64	16,345.99	395.54	767.34	158.93	247.09	1,017.92	1,112.57
N. Hampshire	60,000	44,270.86	3,629.62	943.27	288.82	184.15	65.49	798.19	1,052.28
New Jersey	60,000	43,741.50	4,871.11	541.91	426.42	9.82	85.36	1,234.71	321.91
New Mexico	60,000	30,017.46	11,487.76	1,053.11	1,061.24	843.19	741.78	224.33	3,166.55
N.Y. (Cornell)	54,000	45,813.86	532.05	5.19	360.39	21.09		224.42	22.49
N.Y. (State)	6,000	4,436.64	1,200.00					5.20	
North Carolina	60,000	43,870.00	5,599.73	949.55	306.19	124.94	169.09	993.21	783.34
North Dakota	60,000	51,236.46	4,724.17	1,202.83	161.04	5.00		602.23	332.22
Ohio	60,000	48,410.37	7,941.85	126.00	2.13			149.96	500.43
Oklahoma	60,000	32,411.76	15,464.34	553.85	283.05	48.51	21.42	1,502.68	658.11
Oregon	60,000	39,474.50	8,415.80	1,710.32	486.58	154.13	722.20	1,031.03	1,008.86
Pennsylvania	60,000	48,966.39	4,139.62	928.09	234.35	78.02	142.09	316.75	137.63
Rhode Island	60,000	38,798.54	8,137.65	302.68	527.73	223.27	729.01	799.46	406.95
South Carolina	60,000	43,962.91	4,466.97	1,859.72	601.09	289.49	99.98	842.78	574.17
South Dakota	60,000	34,548.47	9,746.22	3,708.51	708.08	142.00	54.16	1,699.27	901.32
Tennessee	60,000	46,272.75	4,219.64	508.92	112.20	373.90	257.04	881.97	375.30
Texas	60,000	41,630.00	12,937.14		727.84	128.14	61.64	648.66	450.94
Utah	60,000	31,212.32	15,804.22	517.40	509.14	222.85	18.75	1,337.58	1,470.85
Vermont	60,000	32,538.13	11,630.63	2,763.66	818.80	82.89	2,137.55	872.26	385.30
Virginia	60,000	35,151.02	12,276.55	2,979.89	948.19	43.16	131.56	392.81	401.88
Washington	60,000	39,364.16	10,682.74	2,559.96	424.81	29.02	59.04	1,310.78	1,185.97
West Virginia	60,000	43,819.16	5,580.50		42.88	107.20	77.11	713.82	232.57
Wisconsin	60,000	49,508.60	9,674.88					291.80	
Wyoming	60,000	38,684.93	10,626.60	938.89	67.12	512.14	37.40	866.49	802.25
Total	2,880,000	2,001,553.43	378,427.97	54,267.07	17,261.51	8,637.11	13,029.63	44,370.52	31,026.96

the act of Feb. 24, 1925 (Purnell Act), for the year ended June 30, 1933

Classified expenditures—Continued

Fertilizers	Feeding stuffs	Library	Tools, implements, and machinery	Furniture and fixtures	Scientific apparatus	Livestock	Travel expenses	Contingent expenses	Buildings and land	Balance
$5.71	$997.87	$187.60	$1,043.84	$147.65	$535.58	$92.75	$621.32	$738.11		
760.30	327.21	7.20	851.45	174.10	1,367.47	48.00	3,070.36	5.30	$1,449.95	
	500.71	125.59	238.20	79.88	1,027.31		2,501.64	20.00		
278.79	533.51	52.46	700.93	525.19	2,015.34		1,984.70	77.97	241.13	
282.73			1,257.64	60.38	778.19		448.00	142.34	197.08	
		95.04	41.77	357.61			2,539.29			
87.74	1,578.92	141.88	691.91	2,565.93	794.25		2,052.28	228.15	662.82	$724.82
755.14	345.89	13.06	207.32	148.38	923.75	291.78	2,064.65	14.25	859.70	
376.48	2,805.56	88.10	664.84	1,354.12	787.67	283.60	2,145.78		369.62	
20.75	2,694.59	124.25	594.72	312.22	474.97	52.50	3,431.41	30.40	514.63	
	778.68	24.65	3,252.98	166.31	1,726.01	1,691.40	2,387.49	32.55	255.41	1,094.15
25.18	1,160.78		952.00	665.03	2,026.46		7,253.92			
79.98	2,473.05	2.50	299.53	81.40	221.49	657.14	2,856.62	380.25		
	833.16	9.70	926.71	129.42	723.52	836.73	634.44	249.25	163.42	
	509.33	52.82	9.50	38.77	36.41	13.00	1,113.16			
286.26	1,023.71	2.25	2,144.10	88.29	201.60	183.00	927.09	910.68	324.94	
66.75	1,650.09	46.12	1,636.68	554.86	872.16	157.95	4,186.19	738.90	299.79	
314.04		11.82	17.45	40.59	886.84	35.00	2,559.46			
	89.02	92.85	215.33	102.41	228.48	127.15	2,804.09	23.89		
	390.79	60.01	85.42	53.50	59.34		3,019.22	16.90	9.10	
	506.28	6.97	161.40	537.83	626.70	90.72	892.15	28.25		
834.05	1,421.69	85.52	2,763.39	638.99	384.22	241.95	864.12	28.57	404.66	
323.35	3,523.85	19.95	1,359.13	206.05	1,906.07	1,664.92	1,227.38	261.96	5,513.86	
79.39	129.25	82.35	1,001.91	855.94	733.18	273.30	4,206.81	26.55	15.00	
8.25	5,103.63	29.10	254.51	529.93	1,242.10	348.26	2,243.34	5.30	203.02	
	4,248.82	1.50	136.54	299.40	167.82	946.10	2,620.14	81.09	174.57	
447.12	383.01	23.06	467.13	562.07	1,820.29	43.15	3,607.26	60.94	1,353.29	
25.85	269.50	122.91	274.48	379.72	1,059.17	56.50	1,138.33	102.59	5,338.21	
82.50	2,327.32	41.19	1,312.57	970.94	606.91	856.10	3,646.58	62.92	1,497.55	
	67.06	1.56	30.91	582.57	63.70		736.16	5,538.55		
					352.61		5.55			
290.69	3,387.61	108.52	224.95	54.57	478.43	402.88	2,026.59	36.69	193.02	
4.10	156.29	6.42	56.07	11.55	118.66	8.00	1,293.14	68.50	13.32	
	1,716.95		17.86			1,075.87	58.58			
7.50	3,737.42	23.29	1,159.00	206.30	1,143.06	812.38	1,849.37	10.00	107.96	
6.00	496.09	71.65	1,991.39	1,498.78	690.88	1.00	2,082.29	52.25	106.25	
116.64	1,336.02		30.67	333.45	395.03	350.05	2,495.20			
607.85	722.48	29.22	1,364.95	184.45	686.49	27.50	697.18	121.11	5,633.48	
89.26	1,787.74	99.82	871.97	454.64	724.77		2,814.50	37.00	423.19	
10.41	818.40	98.11	950.26	462.92	3,390.16	592.40	1,742.85	.50	425.96	
17.80		375.33	884.92	534.35	2,069.73		968.07	109.76	2,038.32	
	546.46	56.39	349.90	763.24	249.29	14.50	857.49	363.00	215.37	
18.09		96.52	471.45	1,877.66	1,459.62	15.00	4,216.65		751.90	
133.43	825.69	26.13	1,600.79	580.47	718.29	125.00	1,814.10	267.97	2,678.91	
	326.18	83.67	1,197.29	112.98	1,144.44	25.75	4,534.01		250.62	
49.74	674.63	190.18	436.63	101.71	633.57	99.00	2,040.81		157.25	
	2,211.23	1.15	320.76	58.26	994.33	316.83	1,694.73	1.94	3,200.00	627.53
							524.72			
	3,671.33	203.90	406.24	310.65	611.03	270.68	1,790.30	183.05	17.00	
6,491.87	59,087.80	3,022.31	35,929.39	20,755.46	40,157.39	13,127.84	103,289.51	11,057.43	36,060.30	2,446.50

TABLE 10.—*Expenditures from supplementary funds received from within the States for the year ended June 30, 1933*

State	Salaries	Labor	Publications	Postage and stationery	Freight and express	Heat, light, water, and power	Chemical supplies	Seeds, plants, and sundry supplies	Fertilizers	Feeding stuffs
Alabama	$68,848.22	$10,235.83	$1,197.72	$1,806.64	$1,165.74	$4,155.50	$356.77	$4,793.29	$3,352.88	$1,659.91
Alaska		1,144.56								
Arizona	44,909.61	13,030.97	5,861.07	1,587.01	299.27	974.02	2,737.36	109.23	2,833.61	1,269.36
Arkansas	42,276.28	18,701.76		2,848.25	2,224.48	2,181.47	4,664.06	2,074.49	1,863.54	2,587.85
California	410,732.15	188,714.77	24,421.91	18,316.43	7,770.60	22,201.74	22,201.74	44,403.48	7,770.61	56,614.43
Colorado	48,248.70	18,390.85	3,170.50	2,795.69	1,756.73	3,955.99	4,306.23	2,627.53	.75	4,636.14
Connecticut (State)	108,797.82	85,555.19	239.40	3,104.81	382.36	7,738.11	1,770.11	2,506.05	783.40	103.48
Connecticut (Storrs)	24,774.75	11,921.58	786.85	989.64	242.45	1,019.42	2,035.83	1,844.66		1,426.71
Delaware	4,647.32	11,524.15		728.33	223.49	2,902.87	63.90	2,128.34	171.72	2,944.60
Florida	176,162.33	56,078.10	6,079.14	4,784.05	2,293.26	10,884.04	6,000.63	8,740.65	5,605.65	6,841.18
Georgia	2,063.07	3,214.14	421.35	358.57	716.68	476.98	16.37	2,374.89	26.90	2,737.33
Hawaii	14,708.16		321.50	92.70	122.52	998.02	8,820.39			
Idaho	13,093.96	7,455.76	584.68	776.98	306.36	686.47	794.36	2,266.95		2,828.20
Illinois	232,435.79	80,128.09	7,581.72	4,046.19			7,201.00	14,402.00	2,880.19	18,469.78
Indiana	205,255.89	92,564.78	5,258.72	21,429.99	2,172.82	18,294.78	22,775.32	7,624.54	5,600.00	18,528.72
Iowa	193,550.22	25,308.96	11,440.51	5,602.94	1,355.86	1,276.88	4,684.24	21,895.15	468.30	6,012.78
Kansas	38,048.40	51,945.31	1,011.79	3,953.94	1,374.40	6,404.62	1,745.52	5,509.64	92.77	7,116.64
Kentucky	111,658.74	35,041.50	812.77	3,841.24	1,146.11	5,867.82	1,663.30	9,697.43	509.47	5,247.96
Louisiana	75,135.31	26,901.73	295.54	1,070.02	968.52	2,625.26	1,913.18	2,219.78	1,147.87	1,927.53
Maine	22,382.77	15,158.21	70.32	781.34	2,029.43	2,877.89	499.46	2,565.72	1,478.23	1,091.48
Maryland	50,729.78	29,703.18	1,654.21	1,800.00	2,221.96	2,858.99	2,784.28	4,213.20	1,512.06	8,027.52
Massachusetts	104,653.70	34,491.62	2,826.35	2,188.68	1,156.66	1,606.41	5,669.08	3,103.23	535.54	2,479.86
Michigan	140,661.26	79,953.23	15,779.87	2,563.59	1,367.30	4,717.12	5,592.45	10,052.71	1,774.03	7,922.35
Minnesota	167,612.81	71,834.06	7,580.29	9,515.48	1,190.49	19,000.44	368.90	13,046.93		22,586.40
Mississippi	41,736.88	11,159.33	297.26	1,176.68	849.34	3,571.93	342.80	5,431.89		704.93
Missouri	40,391.43	16,117.35	4,120.42	2,438.59	808.92	1,483.90	3,675.07	1,521.40	301.33	5,861.27
Montana	53,714.90	27,819.00	4,500.29	4,529.08	632.23	3,087.35	1,838.88	9,199.11	401.33	4,798.01
Nebraska	82,628.38	22,086.12	4,124.80	1,989.99	881.07	5,776.58	5,656.98	2,971.86	4,591.84	17,354.78
Nevada	80.40	3.55		102.87	66.66	103.59	69.47	244.89		26.80
New Hampshire	18,937.38	4,966.12	272.94	644.49	164.97		1,056.50	2,241.21	193.91	222.51
New Jersey	337,470.25	15,636.15	4,297.70	10,721.85	1,682.83	16,141.34	10,436.23	1,274.38	1,133.79	41,184.52
New Mexico	5,769.90	4,313.12	147.61	225.93	306.42	356.71	75.65	601.99		931.04
New York (Cornell)	381,315.56	64,174.19	16,477.46	10,387.67	1,807.55	23,641.55	14,463.90	15,487.15		11,795.86
New York (State)	168,354.84	34,994.04	7,778.24	4,094.77	599.01	12,742.49	5,462.38	13,145.25		3,231.20
North Carolina	41,026.61	19,180.26	577.00	2,097.51	710.82	3,556.39	935.47	2,883.62	2,673.69	4,938.68
North Dakota	51,085.46	11,233.95	5,161.56	3,953.10	2,146.73	22,665.76	3,657.62	20,305.65		9,877.12
Ohio	244,659.52	93,008.60	27,587.92	3,837.84	1,461.80	20,062.80	1,747.31	13,947.08	599.71	15,404.86
Oklahoma	67,442.94	16,321.74	3,653.16	2,200.99	1,043.26	1,420.95	12,134.15	208.41		3,735.52
Oregon	91,890.80	19,765.83	1,716.81	2,248.84	894.53	4,072.10	3,067.41	4,869.06	202.59	5,078.77
Pennsylvania	78,241.44	27,060.85	1,371.32	2,018.74	897.20		2,467.35	4,934.70	897.22	6,729.14
Rhode Island	1,288.09	3,200.30	42.90	198.58	77.15	139.92	26.65	322.39	29.75	753.00
South Carolina	30,507.46	21,851.68	586.67	848.60	726.22	3,359.51	2,877.07	4,804.54	2,409.55	6,848.63
South Dakota	17,318.31	6,118.62	1,261.65	345.90	236.93	329.42	343.09	815.52		3,227.33
Tennessee	15,099.35	6,947.55	386.53	638.73	314.44	851.85	9.05	877.17	209.78	1,304.47

Texas	249,135.00	75,785.72	8,732.95	8,898.17	2,024.82	10,264.43	5,804.80	18,085.14	1,149.36	10,829.77
Utah	28,419.90	15,623.10	1,637.56	2,188.29	7,693.60	3,389.76	370.46	3,766.39	231.11	2,582.19
Vermont	6,491.67	6,486.37	1,309.05	418.50	116.13	440.77	341.89	696.79	----------	2,612.08
Virginia	50,337.30	11,603.53	317.56	813.42	268.54	619.25	368.74	1,582.82	1,171.67	2,542.98
Washington	43,592.44	31,669.41	1,932.27	881.03	724.58	2,946.29	2,218.83	8,353.95	553.66	8,042.75
West Virginia	28,449.78	21,871.84	1,940.98	1,333.29	772.40	3,718.20	85.51	9,576.02	972.34	3,452.03
Wisconsin	127,688.05	63,262.08	8,186.86	6,140.14	2,604.90	7,442.59	7,442.60	14,885.19	2,604.91	18,978.62
Wyoming	29,923.44	12,824.33	245.00	284.84	734.90	330.59	----------	4,316.22	----------	5,452.50
Total	4,634,384.52	1,634,083.06	206,060.68	170,640.94	63,735.44	276,220.86	195,640.34	335,549.68	58,733.06	381,561.57

TABLE 10.—*Expenditures from supplementary funds received from within the States for the year ended June 30, 1933*—Continued

State	Library	Tools, implements, and machinery	Furniture and fixtures	Scientific apparatus	Livestock	Traveling expenses	Contingent expenses	Buildings and land	Balance	Total
Alabama	$125.79	$810.23	$54.24	$63.33		$4,271.50	$2,509.56	$288.10	$169,615.69	$275,310.94
Alaska							20.00		3.14	1,167.70
Arizona		3,030.18	1,381.77	1,332.08	$6,547.36	3,424.16	234.38	1,427.77	3,541.47	94,530.68
Arkansas	959.96	1,811.16	633.69	3,297.54	1,087.92	1,314.64	761.53	4,847.25		94,135.87
California	4,440.35	27,752.17	7,770.61	12,210.95	18,871.47	39,963.13	13,321.04	74,375.82	108,233.48	1,110,086.88
Colorado	695.83	2,455.86	1,445.41	1,637.48	48.00	5,872.13	594.12	2,756.25	25,490.41	130,884.60
Connecticut (State)	1,332.53	11,474.37	3,203.49	1,108.29	1.44	7,139.16	3,156.11	3,599.43	35,320.39	277,315.94
Connecticut (Storrs)	983.24		222.85	678.90		754.85		359.23	4,007.15	52,048.11
Delaware	44.14	673.50	16.73			186.79		1,203.53	3,304.49	30,763.90
Florida	2,118.28	9,542.83	1,247.92	1,791.04	2,259.43	11,405.58	1,754.19	13,248.69	31,817.84	358,654.83
Georgia	912.47	898.77	502.71		4,617.57	1,662.75	2,041.81	8,916.91	10,599.21	42,558.48
Hawaii		623.18		34.45	154.62	142.39	1,497.79	108.23	1,447.97	29,071.92
Idaho	98.97	866.32	329.38	221.23	319.65	1,489.97	1,813.33	1,121.68	610.63	35,664.88
Illinois	208.38	1,389.21	347.30	590.42	937.72	7,143.02	3,149.22			380,910.03
Indiana	2,470.33	9,752.31	2,754.39	3,657.44	525.45	17,893.04	6,363.53	15,955.52	142,934.05	601,811.62
Iowa	12.80	2,555.72	1,654.75	5,885.56	2,485.80	5,965.56	1,623.09		2,639.94	294,419.06
Kansas	113.63	8,842.03	456.64	234.63	734.19	4,629.87	1,331.22	19,926.16	21,776.65	175,248.05
Kentucky	903.90	2,264.88	800.78	1,300.59	1,117.28	6,798.97	13,628.26	3,445.14	15,723.99	221,470.13
Louisiana	47.37	2,246.98	125.72	280.94	745.29	4,300.51	1,491.82	3,764.79	1,763.78	128,971.94
Maine	660.53	2,118.37	966.72	687.90	4.00	1,747.46	719.32	12,750.21	21.81	68,611.17
Maryland	528.19	4,505.52	1,525.58	3,577.20	1,149.96	2,095.28	1,801.26	2,131.16	13,544.48	136,363.81
Massachusetts	612.30	1,925.95	908.88	1,550.27	154.17	5,101.17	299.56	664.78	70,374.80	240,301.01
Michigan	1,350.33	3,682.74	1,320.99	1,589.37	4,233.65	10,699.91	940.05	2,962.20		297,163.15
Minnesota	1,628.23	7,363.64	3,313.44	28,163.92	18,419.30	6,288.05	3,220.74	6,189.87		387,322.99
Mississippi	12.40	4,466.21	153.20		900.39	311.60	420.83	1,062.55	17,596.63	90,194.85
Missouri	147.34	3,598.50	358.11	1,731.63	3,210.85	1,701.08	465.62	5,075.73	23,151.18	116,159.72
Montana	509.70	4,148.29	879.49	276.98	564.70	5,661.57	65.00	3,657.36	2.06	126,285.33
Nebraska	214.91	1,511.26	1,332.66	1,765.34	12,224.96	1,955.88	1,242.20	12,714.92		181,024.53
Nevada	351.64	13.25	54.97			469.93	1,637.16	1,018.04	3,821.29	8,064.51
New Hampshire	110.28	941.03	246.40	182.61	135.00	3,463.00	1,126.47	70.00	9,720.27	44,695.09
New Jersey	671.77	3,314.81	702.06	11,889.50	355.00	12,165.02	18,193.61	13,283.96	7,489.18	508,043.95
New Mexico	202.27	423.57	64.07	32.04	60.50	249.75	704.38	265.29	33,452.20	48,182.44
New York (Cornell)	2,920.54	11,895.39	7,737.92	62,276.02	344.83	30,730.44	2,494.73	398,312.63		1,056,263.39
New York (State)	3,031.10	1,159.43	486.26			3,411.69	43.50	14,140.25	166,607.51	439,281.96
North Carolina	176.31	1,654.24	322.55	6.96	611.02	6,644.04	1,271.34	12,287.92	2,307.53	103,861.96
North Dakota	647.96	3,767.57	341.89	302.63	4,482.98	5,217.23	4,981.73	5,539.25	39,395.51	194,763.70
Ohio	804.77	1,732.22	18.32	242.88	5,211.99	7,796.12	6,198.09	28,531.18	178,778.40	651,631.41
Oklahoma	885.66	1,845.13	355.22	1,198.13	1,716.23	6,195.80	8,033.28	3,651.43	42,760.10	174,802.10
Oregon	25.61	1,329.17	707.77	1,171.28	6,528.00	6,477.54	12,253.09	1,541.31	37,992.69	201,833.20
Pennsylvania	223.93	1,482.84	373.21	644.46	1,007.67	4,486.12			1,548.12	134,384.31
Rhode Island	60.90	346.93	71.08	7.88		409.47	71.47	556.18		7,602.64
South Carolina	19.00	3,394.14	360.53	2,204.50	752.40	2,491.01	26.00	1,985.66	10,258.28	96,311.45
South Dakota	15.00	853.54	51.25	108.98	3,114.30	1,643.42	14.76	827.29	8,440.47	45,065.78
Tennessee	7.96	826.83	38.75	1.00	194.55	237.82	373.47	755.91		29,075.21

Texas	1,474.49	9,704.84	2,284.91	2,586.90	6,835.32	26,203.80	20,470.97	20,339.42	62,990.86	543,601.67
Utah	366.37	283.96	201.79		1,610.68	2,597.43	573.32	3,029.88		74,565.79
Vermont	73.98	576.22	168.73		27.00	1,974.04	105.92	241.79	538.20	22,619.13
Virginia	731.89	385.48	268.72	474.88	365.70	4,680.78	111.55	2,165.17	7,855.95	86,665.93
Washington	2,249.38	620.60	785.33	3,220.04	1,693.61	3,774.89	39.75	7,346.30		120,645.11
West Virginia	7.92	1,812.77	526.80	17.00	2,257.77	1,110.25	2,356.90	2,330.85	4,388.05	86,980.70
Wisconsin	1,488.52	9,303.25	2,604.90	4,093.43	6,326.21	13,396.67	4,465.56	24,932.70	46,282.68	372,129.86
Wyoming		559.79	49.31		509.05	994.99	7,491.69	1,324.45	19,508.47	84,549.57
Total	37,679.15	178,537.18	52,530.19	164,328.60	125,454.98	306,741.27	157.504.32	747.030.14	1,387,657.00	11,114,072.98

TABLE 11.—*Disbursements from the United States Treasury to the States and Territories for agricultural experiment stations under the acts of Congress approved Mar. 2, 1887, Mar. 16, 1906, Feb. 24, 1925, and May 16, 1928*

State or Territory	Hatch Act		Adams Act		Purnell Act	
	1888–1932	1933	1906–32	1933	1926–32	1933
Alabama	$673,946.42	$15,000.00	$371,619.89	$15,000.00	$320,000.00	$60,000.00
Alaska	15,000.00	15,000.00				
Arizona	639,803.10	15,000.00	374,955.61	15,000.00	320,000.00	60,000.00
Arkansas	673,139.12	15,000.00	374,900.00	15,000.00	320,000.00	60,000.00
California	675,000.00	15,000.00	374,926.84	15,000.00	320,000.00	60,000.00
Colorado	674,718.82	15,000.00	373,638.93	15,000.00	320,000.00	60,000.00
Connecticut	675,000.00	15,000.00	375,000.00	15,000.00	320,000.00	60,000.00
Dakota Territory	56,250.00					
Delaware	673,382.87	15,000.00	370,475.12	15,000.00	318,935.61	60,000.00
Florida	674,966.04	15,000.00	374,996.06	15,000.00	316,523.74	60,000.00
Georgia	670,593.43	15,000.00	362,092.87	15,000.00	320,000.00	60,000.00
Hawaii	45,000.00	15,000.00	11,951.14	9,000.00		
Idaho	599,324.13	15,000.00	370,842.22	15,000.00	320,000.00	60,000.00
Illinois	674,564.95	14,983,26	374,851.62	15,000.00	320,000.00	59,931.91
Indiana	674,901.19	15,000.00	375,000.00	15,000.00	320,000.00	60,000.00
Iowa	675,000.00	15,000.00	375,000.00	15,000.00	317,965.17	60,000.00
Kansas	674,995.00	15,000.00	375,000.00	15,000.00	320,000.00	60,000.00
Kentucky	674,996.57	15,000.00	375,000.00	15,000.00	320,000.00	60,000.00
Louisiana	675,000.00	15,000.00	375,000.00	15,000.00	320,000.00	60,000.00
Maine	674,999.62	15,000.00	375,000.00	15,000.00	320,000.00	60,000.00
Maryland	674,967.40	15,000.00	374,236.48	15,000.00	320,000.00	60,000.00
Massachusetts	674,617.70	15,000.00	375,000.00	15,000.00	320,000.00	60,000.00
Michigan	674,676.10	15,000.00	371,341.20	15,000.00	320,000.00	60,000.00
Minnesota	674,917.78	15,000.00	374,345.00	15,000.00	320,000.00	60,000.00
Mississippi	675,000.00	15,000.00	375,000.00	15,000.00	320,000.00	60,000.00
Missouri	670,097.24	15,000.00	374,999.90	15,000.00	320,000.00	60,000.00
Montana	585,000.00	15,000.00	372,417.04	15,000.00	320,000.00	60,000.00
Nebraska	674,932.16	15,000.00	375,000.00	15,000.00	320,000.00	60,000.00
Nevada	674,214.32	15,000.00	373,180.28	15,000.00	320,000.00	60,000.00
New Hampshire	675,000.00	15,000.00	375,000.00	15,000.00	320,000.00	60,000.00
New Jersey	674,949.97	15,000.00	374,392.06	15,000.00	320,000.00	60,000.00
New Mexico	639,509.05	15,000.00	375,000.00	15,000.00	320,000.00	60,000.00
New York	674,757.18	15,000.00	374,463.01	15,000.00	320,000.00	60,000.00
North Carolina	675,000.00	15,000.00	360,000.00	15,000.00	320,000.00	60,000.00
North Dakota	616,502.26	15,000.00	374,638.85	15,000.00	320,000.00	60,000.00
Ohio	675,000.00	15,000.00	373,514.02	15,000.00	320,000.00	60,000.00
Oklahoma	599,002.16	15,000.00	354,535.19	15,000.00	320,000.00	60,000.00
Oregon	660,156.64	15,000.00	370,000.00	15,000.00	320,000.00	60,000.00
Pennsylvania	674,967.43	15,000.00	374,995.41	15,000.00	320,000.00	60,000.00
Rhode Island	675,000.00	15,000.00	369,520.20	15,000.00	320,000.00	60,000.00
South Carolina	674,542.15	15,000.00	373,460.12	15,000.00	320,000.00	60,000.00
South Dakota	618,250.00	15,000.00	370,000.00	15,000.00	320,000.00	60,000.00
Tennessee	675,000.00	15,000.00	375,000.00	15,000.00	320,000.00	60,000.00
Texas	675,000.00	15,000.00	372,592.26	15,000.00	320,000.00	60,000.00
Utah	540,000.00	15,000.00	374,821.94	15,000.00	320,000.00	60,000.00
Vermont	675,000.00	15,000.00	375,000.00	15,000.00	320,000.00	60,000.00
Virginia	672,824.12	15,000.00	374,949.01	15,000.00	320,000.00	60,000.00
Washington	612,102.65	15,000.00	371,080.11	15,000.00	320,000.00	60,000.00
West Virginia	674,978.71	15,000.00	372,859.12	15,000.00	320,000.00	60,000.00
Wisconsin	675,000.00	15,000.00	375,000.00	15,000.00	320,000.00	60,000.00
Wyoming	660,000.00	15,000.00	375,000.00	15,000.00	320,000.00	60,000.00
Total	31,841,546.28	749,983.26	17,911,591.50	729,000.00	15,353,424.52	2,879,931.91